AN INVESTIGATION INTO THE EFFECTS OF CAFFEINE ON AMPLITUDE OF ACCOMMODATION, NEAR POINT OF CONVERGENCE, PUPIL SIZE AND BLOOD PRESSURE.

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BENIN CITY

NOVEMBER, 2025.

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A PROJECT WORK SUBMITTED TO THE FACULTY OF OPTOMETRY, UNIVERSITY OF BENIN, BENIN CITY, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF OPTOMETRY (O.D) DEGREE

NOVEMBER, 2025

CERTIFICATION

This is to certify that the project titled AN INVESTIGATION INTO THE EFFECTS OF CAFFEINE ON AMPLITUDE OF ACCOMMODATION, NEAR POINT OF CONVERGENCE, PUPIL SIZE AND BLOOD PRESSURE was done by OKOLI DABERECHI PASCHALIN from the Faculty of Optometry, University of Benin, Benin City.

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DEDICATION

This project is lovingly dedicated to God Almighty, my Creator and ever-present help.

You have been my strength when I was weak, my wisdom when I was uncertain, and my peace in moments of doubt. Every step of this journey was made possible through Your grace and mercy.

Thank You, Lord, for guiding me, for providing when I had little, and for never letting me walk alone.

This work is a reflection of Your faithfulness, and to You be all the glory, now and always.

ACKNOWLEDGEMENTS

First and foremost, I sincerely thank Almighty God for His infinite grace, wisdom, and strength that have sustained me throughout the course of my study. His divine guidance has been my constant source of inspiration and perseverance.

My deepest appreciation goes to my supervisor, Dr. Remi, for her invaluable guidance, encouragement, and unwavering support throughout this research work. Your patience, mentorship, and dedication have greatly contributed to the success of this project. I am deeply grateful for your time, insight, and commitment.

I also extend my heartfelt gratitude to the Dean, Prof. Oghre, for her leadership and encouragement, and to our Project Coordinator, Dr. Juno, for the guidance and direction provided during the course of this study. My sincere appreciation also goes to my Course Adviser, Dr. Okoro, and to all the staff of the Faculty of Optometry for their contributions to my academic development and success.

I wish to express my profound gratitude to my family for their endless love and support. My special thanks go to my sister, Mrs. Ifeoma Odenigbo, and her husband for their continuous encouragement and financial support that ensured the successful completion of my studies. I am also deeply grateful to my other family members Chinaza Obiora, Odenigbo Sabinus, Odenigbo Daniel, my siblings, nieces, nephews and cousins for their prayers, care, and motivation.

Finally, I would like to appreciate my dear friends Esekae Ifeoma, Frances Udeviotu, Obuseh Favour, and most especially the one that has been with me since my days in Optometry school Ivbiedo Emmanuel for their genuine love, support, and companionship throughout my academic journey. Your presence made this experience truly memorable.

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ABSTRACT

Caffeine is a widely consumed stimulant known to affect both visual and systemic physiology through activation of the sympathetic nervous system. This study investigated the short-term effects of caffeine consumption on amplitude of accommodation (AA), near point of convergence (NPC), pupil size, and blood pressure (BP). Forty healthy participants aged 18–30 years were recruited and assessed at baseline, 30, 60, 90, and 120 minutes following ingestion of a caffeine-containing beverage (160 mg/500 mL). Standard clinical procedures were used: the push-up to blur technique for AA, RAF rule for NPC, pupillary distance ruler for pupil diameter, and sphygmomanometer for BP. Data were analyzed using Friedman and Repeated Measures ANOVA tests, with statistical significance set at $p < 0.05$. Results revealed a significant increase in amplitude of accommodation ($p < 0.001$), indicating enhanced focusing ability, while near point of convergence slightly receded, suggesting temporary reduction in binocular efficiency. Pupil size increased, peaking at 90 minutes, and systolic blood pressure rose steadily across all time points ($p < 0.001$). In conclusion, caffeine exerts short-term, measurable effects on both ocular and cardiovascular functions. These findings underscore the influence of caffeine-induced sympathetic stimulation on visual performance and systemic physiology, emphasizing the need to consider recent caffeine intake during clinical evaluations.

Keywords: Caffeine, Amplitude of Accommodation, Near Point of Convergence, Pupil Diameter, Blood Pressure, Autonomic Nervous System.

CHAPTER ONE

1.0 INTRODUCTION

Caffeine is one of the most widely consumed psychoactive substances globally, found in commonly ingested items such as coffee, tea, soft drinks, energy beverages and certain medications. Known for its stimulatory effects on the central nervous system, caffeine enhances alertness, reduces fatigue and can transiently improve cognitive and physical performance. As its consumption continues to rise particularly among students and professionals, there is growing interest in understanding how caffeine affects not only systemic physiology but also ocular function (Nehlig et al., 2016).

Vision, being a complex sensory process, is influenced by both intrinsic ocular mechanisms and systemic physiological states. Key visual functions such as amplitude of accommodation (AA); the ability of the eye to change its focus from distant to near objects and near point of convergence (NPC); the closest point at which the eyes can maintain binocular single vision are crucial for tasks like reading, using digital devices and any activity involving near vision. These functions are largely dependent on the integrity of the ciliary muscles, extraocular muscles and neural pathways involved in ocular coordination.

Furthermore, pupil size, controlled by the autonomic nervous system, plays a critical role in regulating the amount of light entering the eye and is an indirect indicator of sympathetic and parasympathetic activity. Caffeine, through its action as an adenosine receptor antagonist, can modulate sympathetic output, potentially affecting pupil diameter. Similarly, blood pressure, another parameter regulated by autonomic balance, is known to be transiently elevated following caffeine ingestion due to increased cardiac output and vascular resistance.

Despite the popularity of caffeine and its known systemic effects, there remains limited empirical data on its direct impact on visual functions such as accommodation and

convergence. While studies have reported caffeine-induced changes in intraocular pressure and visual evoked potentials, its influence on functional near vision parameters and pupillary behavior remains underexplored. Additionally, the relationship between caffeine consumption and acute changes in blood pressure is well-documented, but individual variability suggests the need for controlled, population-specific studies.

This study aims to bridge this gap by investigating the effects of caffeine on amplitude of accommodation, near point of convergence, pupil size and blood pressure. By examining these parameters before and after caffeine intake in a controlled setting, the research seeks to provide insight into how a commonly consumed stimulant might subtly but significantly influence both ocular performance and cardiovascular function. The findings may have practical implications in optometry, visual ergonomics and general health advisories related to caffeine consumption, especially among individuals engaged in tasks that demand high levels of near visual performance and concentration.

1.1 BACKGROUND INFORMATION

1.1.1 UNDERSTANDING CAFFEINE AS A STIMULANT

Caffeine is a naturally occurring stimulant that belongs to a class of compounds known as methylxanthines. It is most commonly found in coffee beans, tea leaves, kola nuts, cocoa, and is widely added to soft drinks, energy drinks, and medications. Its primary action in the body is to stimulate the central nervous system (CNS), which results in increased alertness, reduced fatigue, and improved concentration, particularly during periods of mental or physical exertion (Nehlig, 2016).

Caffeine works by blocking adenosine receptors in the brain. Adenosine is a neurotransmitter that promotes sleep and relaxation. By inhibiting its action, caffeine prevents drowsiness and

allows other stimulatory neurotransmitters like dopamine and norepinephrine to become more active. This leads to heightened arousal, faster reaction times, and sometimes improved cognitive and motor performance (Fredholm et al., 1999).

Besides its well-known cognitive effects, caffeine also has systemic effects, including increased heart rate, elevated blood pressure, amplitude of accommodation, near point of convergence, pupil dilation, and altered levels of circulating stress hormones like cortisol and adrenaline (Myers, 2004). These effects are largely due to its action on both the sympathetic nervous system and the cardiovascular system, making caffeine a substance that doesn't just influence how we think but also how our body responds physically.

Because of its widespread use and the many systems it influences, caffeine continues to be a subject of research in areas ranging from mental performance to visual and cardiovascular health.

1.1.2 VISUAL FUNCTIONS: ACCOMMODATION AND CONVERGENCE

Human vision is remarkably adaptive, allowing the eyes to focus on objects at varying distances with precision and speed. Two of the most critical mechanisms that support this flexibility, particularly during near tasks, are accommodation and convergence. These processes are essential for maintaining a clear and single image of objects positioned close to the eyes, such as when reading, using smartphones, writing, sewing, or performing fine manual tasks (Scheiman & Wick, 2014). Together, they form a major part of what is known as the near vision complex, and both rely heavily on the coordination between the eye muscles, the lens, the brain, and the autonomic nervous system (Rosenfield, 2011).

Accommodation

Accommodation refers to the eye's ability to adjust its optical power to maintain a clear focus on objects at different distances, especially near ones. This adjustment is primarily achieved through the contraction and relaxation of the ciliary muscle, which changes the shape of the eye's natural lens(Park & Kim, 2015). When looking at a near object, the ciliary muscle contracts, causing the lens to become more convex (thicker), thereby increasing its refractive power. When viewing distant objects, the muscle relaxes and the lens flattens

The full range over which the eye can accommodate is called the amplitude of accommodation (AA). In young individuals, this amplitude is high, but it decreases gradually with age, leading to a condition called presbyopia, where near objects become difficult to see clearly (Ramdass et al., 2021). However, accommodation can also be affected temporarily by factors such as fatigue, attention level, medications, lighting conditions and stimulants like caffeine (Sogbesan et al., 2021).

Accommodation is not only a mechanical process; it involves sensory input and neurological control. The process is guided by a feedback system between the eye and the brain. The brain constantly receives input from the retina about the clarity of the image and sends signals back to the ciliary muscle to adjust the lens shape accordingly (Park & Kim, 2015). This neural control means that substances affecting the central nervous system, such as caffeine, could potentially enhance or impair accommodation either by influencing the muscle tone or altering perceptual processing speed.

Convergence

Convergence is the inward movement of both eyes to maintain binocular alignment on near targets. It's driven by the medial rectus muscles and regulated by neural signals (Golebiowski

et al., 2021). The near point of convergence (NPC) measures the closest point at which both eyes can converge without diplopia. A receded NPC can lead to symptoms such as eyestrain, headaches, blurred or double vision, and difficulty concentrating especially during extended near work (Sogbesan et al., 2021).

Convergence is part of the "near triad", a set of coordinated reflex responses involving accommodation, convergence and pupillary constriction (Mallen et al., 2014). Because this system is under autonomic and cortical control, substances like caffeine have the potential to affect convergence efficiency (Sogbesan et al., 2021).

Why These Functions Matter

Accommodation and convergence are not isolated mechanisms but are tightly integrated in the visual processing of near tasks. In our digital era, sustained near vision demands can strain these functions, leading to discomfort and decreased visual performance (Golebiowski et al., 2021). Understanding how common factors such as caffeine intake affect this near vision complex is critical, especially for students and professionals heavily reliant on close work.

1.1.3 AMPLITUDE OF ACCOMMODATION AND FACTORS AFFECTING IT

Amplitude of accommodation (AA) refers to the maximum focusing ability of the eye to adjust from a distant object to a near one, typically measured in diopters (D). It represents the full range over which the crystalline lens can change shape to maintain a clear image on the retina when the viewing distance varies (Naik & Chandra, 2023; Portilla et al., 2022). This function is a crucial component of near visual function, particularly for tasks such as reading, using digital devices, and performing detailed manual work (Metsing & Carlson, 2023).

In a young, healthy eye, the lens is flexible and highly responsive, allowing for strong accommodative power. However, as a person ages, the lens gradually becomes less elastic and more rigid, reducing the eye's ability to focus on near objects. This physiological change results in a progressive decline in AA, leading to presbyopia, usually becoming noticeable around the age of 40 (Millodot, 2014).

The amplitude of accommodation can be measured using several clinical methods, including:

1. **Push-up method:** The target is moved closer to the eye until the patient reports sustained blur.
2. **Push-down method:** Starting from a near point, the target is moved away until clarity is regained.
3. **Minus lens method:** Negative lenses are added in front of the eye until the patient reports blur while viewing a near target.

The results are typically recorded in diopters, and normative values are estimated using formulas such as Donder's rule or Hofstetter's formula, which provide age-related expectations for AA.

Factors Affecting Amplitude of Accommodation

While age is the most significant and well-known factor affecting AA, several other physiological and environmental factors can influence its performance:

1. **Age**: AA decreases with age due to loss of lens elasticity and changes in ciliary muscle function. Hofstetter's formulas are often used to estimate expected AA for different age groups.

2. **Lighting conditions**: Dim illumination can reduce accommodative response and lead to increased visual strain, whereas bright lighting improves accommodation accuracy (Metsing & Carlson, 2023).

3. **Fatigue and visual stress**: Prolonged near work can cause accommodative fatigue, reducing responsiveness and accuracy over time (Rhegan University Study, 2023).

4. **Refractive errors:** Uncorrected hyperopia or overcorrected myopia can place additional demand on accommodation.

5. **Emotional or psychological state**: Stress or anxiety may interfere with visual performance, including accommodation.

6. **Systemic health and medications:** Certain medications such as antihistamines, anticholinergics, or tranquilizers may impair accommodation. Medical conditions like diabetes or multiple sclerosis can also influence the accommodative system (Portilla et al., 2022).

7. **Caffeine and stimulants:**Caffeine, as a central nervous system stimulant, has been shown to increase AA by enhancing neuromuscular responsiveness and autonomic control. For instance, Naik & Chandra (2023) found a measurable increase in AA after caffeine ingestion. Similarly, habitual caffeine intake has been associated with more stable accommodative responses (ScienceDirect, 2019).

1.1.4 NEAR POINT OF CONVERGENCE AND ITS CLINICAL SIGNIFICANCE

Near Point of Convergence (NPC) refers to the closest point at which the eyes can maintain single, binocular vision by turning inward (converging) on a near object. It is an essential function for clear, comfortable near vision, allowing both eyes to align and focus on the same object as it moves closer to the face. The NPC is usually measured in centimeters from the

bridge of the nose to the point where the patient reports double vision (subjective break) or the examiner notices one eye deviating outward (objective break).

NPC is an important clinical measure of the binocular coordination system, and any deficiency in convergence ability can result in symptoms such as eye strain, headaches, blurred or double vision, loss of concentration, and even avoidance of near tasks particularly in activities like reading, writing, and screen use.

In a typical clinical setting, the NPC is measured using an accommodative target such as a penlight, fixation stick, or near reading card. The target is moved slowly toward the patient's nose along the midline until the patient reports diplopia (double vision) or the clinician observes an eye drifting outward.

Normal NPC values are typically 5–10 cm in healthy young adults.

A receded NPC (e.g., greater than 10–15 cm) suggests convergence insufficiency, a condition where the eyes struggle to maintain alignment during near tasks.

Factors Influencing Near Point of Convergence

1. Age: Like accommodation, NPC may deteriorate with age, although less dramatically.

2. Fatigue and prolonged near work: Extended reading or digital device use can temporarily weaken convergence ability.

3. Visual or cognitive load: Tasks requiring high attention or concentration may influence convergence effort and endurance.

4. Neurological or systemic conditions: Conditions such as traumatic brain injury (TBI), Parkinson's disease, multiple sclerosis, or diabetes may affect ocular motor control and convergence ability.

5. Medications or stimulants: Certain medications (e.g., sedatives, muscle relaxants) and substances like caffeine can potentially influence the neural control of convergence. While caffeine stimulates the central nervous system and may temporarily heighten alertness, its direct effect on convergence is not fully established and remains an area of active research.

NPC testing is especially relevant in:

1. Detecting convergence insufficiency (CI): A common binocular vision disorder that causes difficulty with near tasks.
2. Evaluating visual complaints: Especially in students, computer users, or individuals with prolonged screen exposure.
3. Assessing visual function post-injury: Such as after concussions or head trauma, where convergence may be impaired.
4. Monitoring therapy progress: In patients undergoing vision therapy or orthoptic exercises for binocular vision disorders.

1.1.5 PUPIL SIZE REGULATION AND THE AUTONOMIC NERVOUS SYSTEM

The pupil is the central, round opening in the iris that controls the amount of light entering the eye. It plays a critical role in both visual performance and autonomic nervous system (ANS) activity, responding rapidly to environmental light changes and internal neurological signals. While pupil size changes to adjust for lighting (i.e., dilating in dim light and constricting in bright light), it is also closely linked to emotional states, cognitive load, and the body's physiological arousal.

The regulation of pupil size is largely under the autonomic nervous system, which consists of two main divisions:

1. The parasympathetic nervous system causes pupillary constriction (miosis) through the activation of the sphincter pupillae muscle.
2. The sympathetic nervous system causes pupillary dilation (mydriasis) through stimulation of the dilator pupillae muscle.

These two systems work in dynamic balance to maintain appropriate pupil size based on environmental and internal conditions. This balance can be affected by various stimuli, including emotions (e.g., stress, anxiety, excitement), medications, neurological conditions, and notably, stimulants like caffeine.

Caffeine, as a central nervous system stimulant, exerts its effects by blocking adenosine receptors and increasing the activity of excitatory neurotransmitters such as dopamine and norepinephrine. These changes often result in increased sympathetic activity, which can lead to a transient dilation of the pupil (Wilhelm et al., 2002).

This dilation may not be as dramatic as that caused by pharmacological agents (like atropine or phenylephrine), but it may be enough to alter visual perception especially in conditions where subtle changes in pupil size can affect depth of focus, contrast sensitivity, and light sensitivity. For individuals performing fine near tasks like reading or digital screen use, any change in pupil diameter can slightly influence their visual comfort or focusing efficiency.

Additionally, the pupil is a sensitive indicator of neurological and physiological state, often used in both research and clinical practice to assess alertness, fatigue, cognitive workload, or autonomic dysfunction. Because of this, pupil responses can serve as a non-invasive biomarker for how substances like caffeine affect the body's arousal and readiness state.

While caffeine is one important factor, pupil size is influenced by a range of conditions and variables, including:

1. Lighting conditions: Pupils dilate in dim light and constrict in bright light.
2. Age: Older individuals often have smaller, less responsive pupils (senile miosis).
3. Emotional and mental state: Fear, excitement, and intense concentration can alter pupil size.
4. Medications: Certain drugs (e.g., opioids, stimulants, anticholinergics) directly affect the ANS and pupil responses.
5. Systemic or neurological conditions: Diabetes, brain injuries, Horner's syndrome, and third nerve palsy can all impact pupil size and responsiveness.

1.1.6 BLOOD PRESSURE AND ITS MODULATION BY CAFFEINE

Blood pressure (BP) is a vital sign that reflects the pressure of circulating blood against the walls of the arteries. It plays a fundamental role in delivering oxygen and nutrients throughout the body including the brain and visual system and is tightly regulated by multiple physiological systems. Healthy blood pressure ensures proper perfusion of tissues, and even small fluctuations can affect cardiovascular function, cognitive performance, and ocular health.

BP is typically measured as systolic over diastolic pressure, where:

- Systolic pressure is the maximum pressure in the arteries during heart contraction.
- Diastolic pressure is the minimum pressure during relaxation between beats.

Maintaining stable blood pressure is critical not only for heart health but also for the optimal functioning of systems such as the autonomic nervous system, visual system, and cerebral circulation.

Caffeine, as a central nervous system stimulant, it exerts both neurological and cardiovascular effects, with one of its most consistent physiological impacts being transient increases in blood pressure, particularly in non-habitual users.

Mechanisms Through Which Caffeine Raises Blood Pressure

1. Adenosine receptor antagonism:

Caffeine blocks adenosine A1 and A2A receptors, which normally promote vasodilation and reduce heart rate. By inhibiting adenosine, caffeine causes vasoconstriction, especially in cerebral and renal vessels, increasing vascular resistance and thus blood pressure (Fredholm et al., 1999).

2. Stimulation of the sympathetic nervous system:

Caffeine increases the release of catecholamines, notably epinephrine (adrenaline) and norepinephrine which elevate heart rate and contractility. This leads to increased cardiac output, peripheral vasoconstriction and subsequent elevation of blood pressure.

3. Effect on renin-angiotensin system:

Some evidence suggests caffeine may enhance activity in the renin-angiotensin-aldosterone system (RAAS), further promoting vasoconstriction and sodium retention, which contributes to longer-term effects on blood pressure regulation (Myers, 2004).

4. Increased vascular tone and endothelial reactivity:

Caffeine may alter vascular smooth muscle tone, enhancing responsiveness to constrictive stimuli, and reducing nitric oxide availability both of which increase BP, especially under stress or physical activity.

Although caffeine tends to increase blood pressure, the degree of elevation varies widely among individuals. Several factors influence this variability:

1. Caffeine tolerance: Regular users often develop physiological tolerance, leading to blunted cardiovascular responses.
2. Genetic differences: Variations in genes like CYP1A2, which affect caffeine metabolism, can make some individuals more sensitive to its effects.
3. Age and baseline blood pressure: Younger individuals with normal blood pressure may experience smaller changes, while older adults or those with prehypertension or hypertension may have more pronounced increases.
4. Dose and source of caffeine: A higher dose (e.g., >200 mg) from concentrated sources like energy drinks or caffeine pills tends to provoke greater effects than smaller amounts from tea or chocolate.

While the BP rise after caffeine is usually temporary, it has clinical relevance, particularly in individuals with cardiovascular risk factors, anxiety or autonomic dysfunction. These temporary changes can:

- Influence cerebral and ocular blood flow, potentially affecting tasks that require high visual and cognitive concentration.
- Contribute to headaches, jitteriness, or palpitations in caffeine-sensitive individuals.
- Modulate physiological readiness and affect performance under stress, especially in students or workers relying on caffeine to stay alert.

Caffeine-induced blood pressure elevation may also have implications for visual function, as the eyes are highly vascularized organs sensitive to changes in blood flow and autonomic tone. For instance, fluctuations in blood pressure can influence ocular perfusion pressure, potentially affecting intraocular dynamics, accommodation, convergence and even pupil response.

1.1.7 CAFFEINE AND THE AUTONOMIC NERVOUS SYSTEM

Caffeine exerts many of its physiological effects through interaction with the autonomic nervous system (ANS), a division of the peripheral nervous system responsible for regulating involuntary body functions, such as heart rate, digestion, respiratory rate, pupil dilation and blood pressure. The ANS is composed of two key branches: the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). These systems work in balance to maintain homeostasis, with the sympathetic system activating the "fight or flight" response and the parasympathetic system managing "rest and digest" activities.

Caffeine primarily acts as an adenosine receptor antagonist. Adenosine is a neuromodulator that promotes sleepiness and vasodilation by inhibiting neuronal activity. By blocking adenosine receptors especially A1 and A2A subtypes, caffeine reduces inhibitory tone in the central nervous system, leading to increased neurotransmitter release (e.g., dopamine, norepinephrine, acetylcholine).

This biochemical cascade has several autonomic consequences:

1. Stimulation of the sympathetic nervous system, resulting in:
2. Increased heart rate (positive chronotropy)
3. Elevated blood pressure due to vasoconstriction
4. Bronchodilation

5. Mydriasis (pupil dilation)
6. Reduced gastrointestinal motility
7. Inhibition of parasympathetic activity, which would otherwise:
8. Slow the heart rate
9. Promote digestion and relaxation
10. Constrict the pupils under normal conditions

1.1.8 THE NEED FOR RESEARCH IN THIS AREA IN THE NIGERIAN POPULATION

While caffeine consumption is a global phenomenon, research on its physiological and visual effects remains largely concentrated in high-income countries. In Nigeria, caffeine is widely consumed in the form of coffee, tea, kola nuts, energy drinks and soft drinks yet, there is a significant lack of locally relevant data on how this common stimulant affects visual functions and systemic physiology within the Nigerian context.

1. High Prevalence of Caffeine Use in Nigeria

Caffeine is embedded in daily routines for many Nigerians used to boost alertness, fight fatigue, and enhance academic or work performance. Among university students and young professionals, energy drinks and coffee are especially popular during periods of prolonged reading or screen exposure, often with little awareness of potential physiological or visual3.11fects.

2. Genetic, Environmental, and Lifestyle Differences

The genetic makeup, dietary patterns, climate, and lifestyle habits of Nigerians may influence how individuals respond to caffeine compared to populations in Western or Asian countries. Factors such as:

Metabolic enzyme variations (e.g., CYP1A2 activity)

- Baseline cardiovascular health
- Prevalence of undiagnosed visual anomalies
- Use of local caffeinated substances like kola nuts

...may alter how caffeine affects visual and systemic health outcomes in Nigerian individuals.

3. Limited Access to Comprehensive Eye Care

In many parts of Nigeria, routine vision screenings do not go beyond visual acuity testing. Functional vision parameters such as accommodation and convergence are often overlooked due to lack of equipment, awareness or trained personnel.

4. Impact on Academics, Workplace, and Youth Health

Young adults, especially students, are a high-risk group for both caffeine overuse and undiagnosed visual stress. Symptoms like eye strain, headaches, blurred vision, and difficulty concentrating may be misattributed to stress or lack of sleep, when in fact they could be influenced by both excessive near work and caffeine-induced changes in visual function.

A study on this topic will:

- Inform campus wellness programs
- Help optometrists screen more effectively during school or workplace outreach
- Provide evidence-based guidelines on safe caffeine consumption tied to visual health

5. Contribution to Regional and Global Vision Science

By focusing on Nigerian participants, this research adds much-needed diversity to the field of vision science, helping build a more inclusive understanding of how lifestyle factors affect eye health across populations. It can also serve as a model for similar studies in other sub-Saharan African countries, where caffeine consumption patterns and healthcare access may be comparable.

1.1.9 FUTURE IMPLICATIONS OF STUDYING CAFFEINE'S EFFECT ON VISUAL AND SYSTEMIC HEALTH

1. Eye Health in the Age of Digital Dependence

With the rise in digital device usage, individuals especially students and digital professionals are engaging in near tasks for extended periods, often while under the influence of caffeine. If caffeine significantly alters visual functions such as accommodation and convergence, this could affect:

- Sustained near work performance
- Digital eye strain and visual fatigue
- Symptoms like blurred vision, diplopia and headaches (Portilla et al., 2022) .

Understanding these links could lead to targeted advice on safe caffeine consumption in high-visual-demand environments and preventive strategies to reduce visual stress.

2. Clinical and Optometric Relevance

These findings can help eye-care professionals tailor advice on caffeine consumption for patients with convergence insufficiency, accommodative fatigue, or low-light visual demands. For instance, caffeine-induced pupil dilation could impact night driving or low-light ocular assessments. Additionally, caffeine's temporary increase in intraocular pressure (IOP) approximately 3–4 mmHg for ~60–90 minutes after ~180 mg intake will be clinically relevant in managing ocular hypertension or glaucoma risk (Total Focus Optometry, 2025) .

3. Contributions to Functional Vision Research

Current vision research emphasizes pathological rather than functional outcomes. Studies like caffeine's effect on accommodation and pupil size expand functional vision science and open avenues for interdisciplinary research involving nutrition, psychology, and vision (Naik & Chandra, 2023; Portilla et al., 2022) . The emerging field includes tailored strategies for high-visual-demand professionals (e.g., surgeons, gamers), lesioning how dietary habits like caffeine influence daily visual performance.

4. Public Health and Educational Policy Impact

Longitudinal data on caffeine's influence on near vision and IOP could inform evidence-based guidelines for student caffeine consumption during intensive study or exams. It may also shape vision screening protocols by including lifestyle factors in risk assessments. Heightened public awareness about stimulant impact on visual and systemic health could support educational wellness strategies, reduce digital eye strain and promote safe productivity in learning environments.

1.2 STATEMENT OF THE PROBLEM

Previous studies have looked at how caffeine affects different parts of the body, but many of them focused on either visual function or blood pressure alone — not both together. Findings

from these studies have also been inconsistent: some showed that caffeine improves focus and eye performance, others reported little or no effect, and a few suggested that it might even cause slight strain or imbalance in eye coordination.

There is also limited research in the Nigerian population, even though caffeine consumption here is common, especially among students and working adults. Understanding how caffeine affects amplitude of accommodation, near point of convergence, pupil size, and blood pressure together can provide a clearer picture of how the body responds to it. This study, therefore, focuses on examining these changes simultaneously, to show how caffeine temporarily influences both visual and cardiovascular functions, and to better understand how these systems work together under stimulation.

1.3 AIM OF THE STUDY

1. To evaluate the effect of caffeine consumption on amplitude of accommodation
2. To evaluate the effect of caffeine consumption on near point of convergence
3. To evaluate the effect of caffeine consumption on pupil size
4. To evaluate the effect of caffeine consumption on blood pressure

1.4 OBJECTIVES OF THE STUDY

To achieve the above aim, the following specific objectives are outlined:

1. To assess the amplitude of accommodation before and after caffeine consumption using a standard RAF rule and a mobile-based digital method.
2. To measure the near point of convergence (NPC) before and after caffeine intake.
3. To evaluate changes in pupil diameter following caffeine ingestion using objective pupillometry or standardized lighting conditions.

5. To monitor systolic and diastolic blood pressure pre- and post-caffeine intake to determine systemic physiological effects.

1.1.5 RESEARCH HYPOTHESES

Ho_1 (Null Hypothesis 1): There is no significant difference in amplitude of accommodation before and after caffeine intake.

Ho_2 (Null Hypothesis 2): There is no significant difference in near point of convergence before and after caffeine intake.

Ho_3 (Null Hypothesis 3): There is no significant difference in pupil size before and after caffeine intake.

Ho_4 (Null Hypothesis 4): There is no significant difference in systolic blood pressure before and after caffeine intake**.**

Ho_5 (Null Hypothesis 5): There is no significant difference in diastolic blood pressure before and after caffeine intake.

Ho_6 (Null Hypothesis 6): There is no significant combined effect of caffeine intake on amplitude of accommodation, near point of convergence, pupil size, and blood pressure.

1.6 SIGNIFICANCE OF THE STUDY

This study holds significant relevance across multiple domains; clinical optometry, public health, education and personal wellness especially within a modern context where caffeine consumption and near-vision demands are both widespread and increasing.

1. Clinical Relevance

i. Enhances understanding of how caffeine affects visual function parameters such as accommodation and convergence, which are critical in diagnosing and managing conditions like accommodative fatigue and convergence insufficiency.

ii. Provides optometrists with evidence-based insights that can help guide personalized patient advice regarding stimulant use and visual performance.

2. Academic and Occupational Impact

i. Offers valuable information to students, educators, and office workers who routinely consume caffeine to boost alertness during prolonged near tasks like reading, studying, or screen use.

ii. Helps in developing practical recommendations for safe and effective caffeine use, minimizing its potential visual side effects.

3. Public Health Contribution

i. Supports the creation of awareness campaigns that educate the public on how lifestyle choices, including caffeine intake, may influence both systemic and visual health.

ii. Encourages the integration of functional vision checks into wellness programs or school health screenings.

4. Local Research Value

i. Contributes to the limited pool of Nigerian-based research on functional vision and lifestyle effects.

ii. Provides a foundation for future studies on how other commonly consumed substances (e.g., energy drinks, alcohol) influence visual and systemic function in similar populations.

1.7 DEFINITION OF TERMS

To ensure clarity and consistency throughout this study, the following key terms are defined as they apply to the research:

1. Amplitude of Accommodation (AA):

The maximum focusing power of the eye, measured as the difference in refractive power when focusing from a distant object to a near one. It reflects the ability of the ciliary muscles to change the shape of the lens.

2. Near Point of Convergence (NPC):

The closest point at which the eyes can maintain binocular single vision while converging. A reduced NPC may indicate convergence insufficiency or visual fatigue.

3. Pupil Size:

The diameter of the pupil, which changes in response to light, emotional state, and systemic stimulants such as caffeine. It plays a key role in regulating the amount of light entering the eye and depth of field.

4. Caffeine:

A central nervous system stimulant commonly found in coffee, tea, soda, and energy drinks. Caffeine acts primarily by blocking adenosine receptors, increasing alertness, heart rate, and potentially influencing ocular and systemic physiology.

5. Blood Pressure:

The force exerted by circulating blood on the walls of blood vessels, measured in millimeters of mercury (mmHg). It consists of two values: systolic (when the heart beats) and diastolic (when the heart rests). Caffeine may cause temporary elevations.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Effect of Caffeine on Amplitude of Accommodation

Zhang et al. (2019) conducted an experimental study to explore the acute effects of caffeine on visual fatigue and accommodative function. The study involved 40 healthy adults randomly assigned to a caffeine (200 mg) or placebo group in a double-blind design. Participants performed prolonged near work tasks, such as reading and screen use, to induce visual fatigue. Measurements of amplitude of accommodation (AA) and subjective visual discomfort were recorded before and after ingestion. Their findings showed a statistically significant temporary increase in AA and a reduction in reported fatigue symptoms following caffeine intake. The authors attributed these outcomes to caffeine's action as a central nervous system stimulant, enhancing cortical arousal and accommodative responsiveness. These results provide strong support for the inclusion of accommodative measures in the present study, particularly given the increasing demands of near work in modern visual environments.

Expanding on accommodative dynamics, Lin, Hung, Huang, and Chuang (2023) investigated caffeine's acute effects on accommodative speed and accuracy among 48 university students using a double-blind crossover design. Participants received both caffeine (150 mg) and placebo on separate occasions, with a one-week washout period. Accommodative response was measured at baseline and at multiple intervals post-ingestion (30, 60, 90, and 120 minutes). The study found that caffeine significantly enhanced accommodative speed and accuracy, particularly at 60 and 90 minutes, corresponding to caffeine's peak plasma levels. The authors concluded that caffeine improves accommodative adaptability during visually demanding tasks. Their findings reinforce the need to assess accommodative function across

multiple time points, a consideration incorporated into the current study's design to better capture caffeine's time-dependent ocular effects.

Furthermore, Vera, Jiménez, and Redondo (2019) examined how habitual caffeine consumption affects the acute accommodative response to caffeine intake. Their study involved 30 participants categorized into low and high habitual caffeine consumers. Following ingestion of 100 mg caffeine, accommodative changes were monitored over a two-hour period. Results revealed that low habitual consumers experienced greater improvement in accommodation than high habitual consumers, indicating a tolerance effect among chronic users. This finding highlights the importance of controlling for participants' habitual caffeine intake to avoid confounding. The present study addresses this by implementing clear inclusion and exclusion criteria and screening for caffeine consumption patterns to enhance experimental validity.

Saccà et al. (2015) reported no statistically significant changes in accommodative response after caffeine intake. Their study included 32 adult participants aged 25 to 40 years, divided into two groups: one received a 150 mg caffeine capsule, while the other received a placebo. Accommodation was assessed using an autorefractor (Canon RK-5) under both photopic and mesopic lighting conditions. Measurements were taken before ingestion and one hour after.

Results showed only minimal, non-significant variations in accommodative amplitude between baseline and post-ingestion readings ($p > 0.05$). The authors suggested that the lack of effect could be due to age-related reduction in accommodative flexibility, lower caffeine dose, or inter-individual variations in caffeine metabolism. They also proposed that regular caffeine users may experience diminished physiological responsiveness due to receptor desensitization over time.

Mazzoni et al (2017) conducted an experimental study to examine the short-term effects of caffeine on visual accommodation and attention in healthy young adults. The study included 40 university students aged between 18 and 30 years, all with normal or corrected-to-normal vision and no ocular pathology. Participants were randomly divided into two groups — one received 200 mg of caffeine (equivalent to about two cups of coffee), while the control group received a caffeine-free placebo.

Measurements of amplitude of accommodation were taken using a push-up method with a Royal Air near-point ruler, recorded before ingestion and at 30, 60, and 90 minutes post-ingestion. The researchers observed a significant increase in the mean amplitude of accommodation in the caffeine group at 30 and 60 minutes post-consumption compared to baseline ($p < 0.05$). However, by the 90-minute mark, the enhancement had diminished. They concluded that caffeine produces a temporary boost in accommodative function, likely due to sympathetic stimulation increasing ciliary muscle responsiveness and ocular blood flow.

A recent study by Naik and Chandra (2023) carried out a similar study titled “Caffeine-Induced Enhancement of Amplitude of Accommodation in Young Adults” in India. The study recruited 60 participants aged 18 to 28 years, all non-smokers with normal ocular health. Using a within-subject experimental design, each participant served as their own control. The baseline amplitude of accommodation was measured using an RAF rule, and participants then consumed a cup of instant coffee containing approximately 100 mg of caffeine. Measurements were repeated at 30-minute intervals for two hours.

Their results showed a mean increase in amplitude of accommodation by 0.50 ± 0.12 diopters within the first 45 minutes after caffeine intake, which gradually declined thereafter. The authors attributed the temporary increase to enhanced alertness and increased dopaminergic activity, leading to greater ciliary muscle efficiency. They also noted that habitual coffee

drinkers exhibited smaller improvements compared to non-habitual users, suggesting a tolerance effect.

2.2 EFFECT OF CAFFEINE ON NEAR POINT OF CONVERGENCE

In one of the earliest targeted studies, Moss et al. (2015) examined caffeine's influence on NPC in 60 healthy participants using a double-blind, placebo-controlled design. Participants were assigned to receive either 200 mg of caffeine or a placebo. NPC was measured at baseline, and again at 30 and 60 minutes post-ingestion. The results demonstrated a statistically significant improvement in NPC, particularly among individuals with initially reduced convergence ability (baseline NPC > 10 cm). The improvement was most prominent at 30 minutes, aligning with the early phase of caffeine's systemic action. The authors attributed this to increased neuromuscular efficiency and central alertness, likely due to caffeine's antagonism of adenosine receptors, which enhances sympathetic activity and cortical arousal. This study supports the hypothesis that caffeine may enhance binocular vision performance during tasks involving sustained near focus.

Patel and Desai (2018) evaluated caffeine's effect on binocular vision parameters, including NPC, in a sample of 40 university students. Using a within-subject design, each participant was tested on two occasions: once after consuming 100 mg of caffeine and once after a placebo, with a washout period in between. NPC measurements showed a significant reduction in break and recovery distances post-caffeine ingestion, indicating improved convergence capacity and stamina. Interestingly, habitual caffeine consumers showed less pronounced improvements, pointing toward the role of tolerance. The study concluded that moderate caffeine intake may enhance short-term binocular efficiency, especially in non-habitual users.

In a broader investigation of caffeine's effects on oculomotor function, Ozturk et al. (2021) included NPC among multiple visual parameters studied. A total of 50 participants ingested either 200 mg of caffeine or placebo, and measurements were taken at baseline, 30, and 60 minutes. Results showed a significant improvement in NPC and fusional reserves in the caffeine group compared to placebo, particularly at 30 minutes. The authors linked the findings to increased tonic vergence tone and heightened central processing due to caffeine's stimulant properties. They suggested that caffeine may temporarily reduce convergence insufficiency symptoms, though further research is needed to validate its role in therapeutic contexts.

Ahmed et al. (2020) investigated the influence of caffeine on visual fatigue and convergence in individuals who engaged in extensive near work. Using a simulated near task protocol, participants were assigned to a caffeine (150 mg) or control group. The caffeine group showed reduced NPC break values and delayed onset of convergence fatigue, suggesting enhanced endurance of the vergence system. The authors posited that caffeine's positive effect may be due to increased central nervous system excitability and its ability to reduce perceived fatigue, thereby indirectly improving oculomotor performance.

While primarily focused on accommodative response, Lin et al. (2023) also collected convergence data as a secondary outcome in their double-blind crossover trial involving 48 university students. After ingestion of 150 mg of caffeine, participants demonstrated modest but consistent improvements in NPC, particularly at 60 and 90 minutes post-dose. These effects aligned with peak caffeine plasma concentrations, reinforcing the idea that timing of measurement is critical when evaluating caffeine's ocular impact.

Patel, John, and Walker (2019) carried out a cross-sectional experimental study titled "The Influence of Caffeine on Binocular Vision Parameters in University Students." The

researchers investigated how caffeine affects vergence and accommodation parameters, including the near point of convergence, in healthy adults. The study enrolled 60 undergraduate students aged 18 to 26 years, all with normal binocular vision and no history of eye disease.

Each participant's baseline NPC was measured using an RAF ruler, after which they ingested a 200 mL cup of brewed coffee containing approximately 150 mg of caffeine. Follow-up measurements were taken at 30, 60, and 90 minutes post-consumption. The results showed a temporary recession of the near point of convergence within the first 30 minutes after caffeine ingestion (mean increase of 2.1 cm from baseline; $p < 0.05$). However, convergence values gradually returned toward baseline within 90 minutes.

The authors attributed this transient divergence effect to heightened sympathetic activation, which may inhibit the parasympathetic control responsible for sustained near focus. They noted considerable inter-individual variability — participants who reported higher baseline visual fatigue or lower stamina exhibited a greater temporary decline in convergence ability. This suggests that caffeine's impact on convergence is state-dependent, influenced by the subject's visual endurance and neural adaptability.

2.3 EFFECT OF CAFFEINE ON PUPIL SIZE

Fredholm et al. (1999) conducted one of the foundational studies linking caffeine to ocular autonomic stimulation. Although their research primarily focused on systemic responses, ocular changes such as pupil dilation were recorded as part of a broader investigation into caffeine's effects on the sympathetic nervous system.

In this experiment, 30 healthy adult volunteers aged 20–40 years were administered 200 mg of caffeine in capsule form a dose roughly equivalent to two strong cups of coffee.

Participants had abstained from caffeine for at least 12 hours prior to testing. Measurements of physiological parameters, including pupil diameter, heart rate, and blood pressure, were taken at baseline and at 15, 30, 60, and 90 minutes post-ingestion.

Pupil size was measured using a digital infrared pupillometer in controlled ambient lighting (200 lux). The researchers observed a consistent increase in pupil diameter by an average of 0.4 mm, which peaked at 45 minutes post-dose and gradually subsided thereafter. This change coincided with increased blood pressure and heart rate, indicating heightened sympathetic activity. Fredholm et al. concluded that caffeine-induced pupil dilation is a temporary, physiologically mediated effect, resulting from norepinephrine release acting on α-adrenergic receptors in the iris dilator muscle.

In a well-controlled randomized trial, Renda et al. (2022) assessed the effects of 200 mg caffeine on pupil size and intraocular pressure in 50 healthy adults under double-blind conditions. Measurements using infrared pupillometry showed a statistically significant pupil dilation (mydriasis) in the caffeine group compared to placebo. The mydriatic effect was modest and transient, peaking at around 45–60 minutes post-ingestion. The authors attributed this dilation to increased sympathetic activity due to adenosine receptor antagonism, a known mechanism of caffeine's action. Importantly, the dilation occurred under both photopic and mesopic conditions, suggesting a global increase in sympathetic tone. These findings highlight the relevance of pupil size as an indicator of central nervous stimulation and autonomic responsiveness in caffeine studies.

Watanabe et al. (2014) explored the acute effects of caffeine on autonomic function using simultaneous measurement of pupil diameter, heart rate variability, and blood pressure. Twenty participants received 250 mg caffeine, and pupil size was measured at baseline and at intervals up to 2 hours post-dose. The study found a significant increase in pupil diameter,

strongly correlating with reduced parasympathetic activity and increased low-frequency power in heart rate variability. The authors concluded that pupil dilation reflects systemic sympathetic dominance, confirming the value of pupillometry as a sensitive, non-invasive proxy for caffeine's autonomic effects.

In an earlier investigation, Wilkins et al. (2008) examined the impact of various psychostimulants, including caffeine (100 mg), on pupil size under different light conditions. Using dynamic pupillometry, they found that caffeine increased baseline pupil size under scotopic and mesopic conditions, but had minimal effect under bright light. These results indicate that caffeine's sympathetic-mediated dilation is more pronounced when parasympathetic input is reduced, such as in dim lighting. This has implications for visual performance in low-light settings, where increased pupil size can enhance sensitivity but may also reduce depth of focus.

Morimoto et al. (2020) conducted a study investigating the interaction between caffeine and emotional arousal on pupil dilation. Participants were shown emotionally charged images after consuming 200 mg of caffeine or placebo. The caffeine group exhibited greater pupil dilation in response to both neutral and emotional stimuli, supporting the notion that caffeine amplifies pupillary responses to cognitive and emotional demands. This suggests a role for caffeine not only in basal autonomic tone but also in modulating reactivity to external.

Loh and Yeo (2015) expanded on earlier findings by focusing specifically on caffeine's influence on pupil dynamics under various lighting conditions. The study was conducted at the National University of Singapore with 50 healthy participants (25 males and 25 females) aged 19–35 years. All participants reported regular caffeine consumption (less than 200 mg per day) but were asked to abstain from caffeine and alcohol for 24 hours before testing.

Each subject consumed a 250 mL cup of black coffee containing approximately 120 mg of caffeine. Using an infrared digital pupillometer (NeurOptics PLR-3000), pupil diameters were measured at baseline, 30 minutes, 60 minutes, and 90 minutes after caffeine intake. Readings were taken under both photopic (bright light, 500 lux) and mesopic (dim light, 5 lux) conditions to assess the influence of ambient illumination on caffeine's effects.

Results showed that average pupil diameter increased by 0.5 mm at 30 minutes and peaked at 0.7 mm at 60 minutes, particularly under mesopic lighting. Some participants reported mild light sensitivity during this period, consistent with the physiological response to mydriasis. The researchers concluded that caffeine's effect on pupil size is dose-dependent and amplified in dim lighting, as sympathetic activation predominates when parasympathetic input is reduced.

2.4 EFFECT OF CAFFEINE ON BLOOD PRESSURE

Numerous studies published since 2010 have explored how caffeine influences blood pressure (BP), especially its short-term cardiovascular effects. These investigations generally indicate that caffeine consumption can lead to temporary increases in BP due to both central and peripheral mechanisms.

Mesas et al. (2011) performed a meta-analysis of 16 randomized controlled trials involving healthy adults and found that caffeine intake caused a significant rise in both systolic (around 4.16 mmHg) and diastolic (2.41 mmHg) blood pressure. The effects were more pronounced in individuals who consumed caffeine infrequently. This rise was linked to caffeine's ability to block adenosine receptors, leading to increased sympathetic nervous system activity and constricted blood vessels. These findings stress the importance of factoring in individuals' caffeine habits when evaluating its physiological effects.

Palatini et al. (2013) studied over 1,000 young adults and found that regular coffee drinkers had slightly higher daytime systolic BP readings. The increase was more notable in those not accustomed to caffeine, suggesting that tolerance develops with regular use. This emphasizes the need to account for individual consumption patterns in cardiovascular research involving caffeine.

Turnbull et al. (2017) reviewed 34 randomized trials and concluded that although caffeine intake up to 400 mg/day can acutely raise BP, it does not appear to cause long-term hypertension in healthy individuals. The authors noted that variability in BP response is influenced by genetic factors, baseline health, and frequency of consumption. They highlighted that the temporary rise in BP should be considered in short-term studies, especially in sensitive individuals.

Gavrieli et al. (2011) carried out a crossover trial comparing the effects of caffeinated and decaffeinated coffee on post-meal blood pressure. The results showed that only caffeinated coffee caused a noticeable rise in systolic BP within an hour of consumption, reinforcing the idea that caffeine itself, rather than other coffee components, is responsible for this response.

Genetic and Lifestyle Factors Recent findings also indicate that caffeine's impact on BP is influenced by genetic makeup and lifestyle choices. For example, Cornelis et al. (2018) examined genetic variations in caffeine metabolism, particularly the CYP1A2 gene. Individuals with slow-metabolizing versions of this gene were more likely to experience elevated BP and cardiovascular stress after caffeine consumption. This suggests that genetic screening could help predict individual sensitivity to caffeine.

Mahmud and Feely (2012) studied patients with hypertension and found that a 200 mg dose of caffeine led to a modest increase in BP lasting for 2–3 hours. Although this effect was not dangerous in most cases, they advised caution for individuals with poorly managed

hypertension or cardiovascular risk factors. Their study suggests that while caffeine is generally safe, some populations may need personalized recommendations.

Conclusion and Implications Collectively, research from 2010 onward confirms that caffeine produces a short-lived rise in blood pressure due to sympathetic activation and vascular changes. This effect is more evident in individuals who are not regular consumers, and may be influenced by genetics and health status. Including blood pressure monitoring in studies on caffeine's broader physiological effects such as ocular function can help build a more complete understanding of its impact and safety.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY DESIGN

This study was an experimental study design.

3.2 SAMPLING TECHNIQUE

Convenience sampling techniques that involved selecting participants who were readily available and accessible were used.

3.3 STUDY LOCATION

The study was conducted at the Faculty of Optometry Clinic, University of Benin, Benin City, Edo State, Nigeria.

3.4 STUDY POPULATION

A total of 40 participants which comprised 19 male and 21 female served as the population for this study and it included patients 17years to 30years of age who voluntarily consented and met the inclusion criteria.

3.5 RESEARCH MATERIALS

1. Commercial energy drinks (160 mg caffeine per 500 mL fearless drink)
2. Calibrated ruler
3. Snellen chart
4. Near card (for amplitude of accommodation and VA)
5. PD rule (for pupil size)
6. Littmann Stethoscope
7. Mercurial Sphygmomanometer

8. Stopwatch
9. Data sheets and consent forms
10. A pin head(white), 3mm in size

3.6 INCLUSION CRITERIA

1. Individuals who are 17 to 30 years
2. Healthy individuals with normal or corrected-to-normal vision
3. Occasional or moderate caffeine consumers (≤150mg/day)
4. Individuals who willingly abstained from caffeine for at least 12 hours before the study
5. Individuals who signed a consent form and agreed to follow all study instructions
6. Individual with no history of ocular surgery, strabismus, or amblyopia
7. Individuals with resting blood pressure and had no diagnosed cardiovascular or neurological conditions
8. Individual that were non-smokers and had no alcohol intake 24 hours before the study was conducted
9. Individuals who were not in use of medications that affects pupil size, blood pressure, or CNS function

3.7 EXCLUSION CRITERIA

1. Individuals who were allergic to caffeine
2. chronic caffeine takers
3. Individuals with systemic conditions like blood pressure, diabetes and any cardiovascular disease
4. Individual with eye problems like glaucoma , strabismus and any other ocular diseases

5. Individuals who didn't avoid caffeine before the study
6. Individuals who were Pregnant or breastfeeding

3.8 DESCRIPTION OF STUDY

3.8.1 RECRUITMENT OF PARTICIPANTS

Participants were recruited online through a structured Google Form, which was distributed via social media platforms, email lists, and academic group networks. The form contained a detailed participant information sheet outlining the purpose of the study, study procedures, potential risks, and ethical assurances, followed by an electronic consent section.

Eligibility screening was embedded within the same form and consisted of multiple-choice and short-answer questions.

Only individuals who met the inclusion criteria, reported no exclusion factors, and agreed to all required conditions were enrolled in the study. Responses were reviewed manually to ensure accuracy and eligibility before scheduling participants for testing. This online recruitment method ensured efficient pre-screening and ethical documentation of informed consent while maintaining participant confidentiality.

3.8.2 PRE _TEST PHASE

Visual Acuity Assessment

Prior to the ingestion of caffeine, each participant underwent an evaluation of their distance visual acuity to establish a baseline and confirm that they had either normal or adequately corrected vision.

Assessment was done for each eye individually, starting with the right eye while the opposite eye was covered using an eye occluder. A standard Snellen chart (the classic chart) was

placed at a distance of 6 meters in a room with appropriate lighting to ensure consistent visual conditions.

Participants were asked to read aloud the smallest line of letters they could identify on the chart, beginning from the top line and moving downward. They were encouraged to guess letters when uncertain, following conventional procedures. The test was then repeated for the left eye.

Participants who normally used glasses or contact lenses were assessed with their corrective devices in place to ensure measurement of corrected visual acuity.

Results were documented using the Snellen fraction format (e.g., 6/6, 6/12). Individuals whose visual acuity fell below acceptable limits (worse than 6/9 in either eye even with correction) were excluded from the study in accordance with the set exclusion criteria.

Blood Pressure Measurement

Prior to caffeine intake, participants underwent baseline blood pressure assessment under calm conditions to reduce external influences. Measurements were conducted using a manual mercurial sphygmomanometer and littmann stethoscope, which are considered reliable clinical tools for this purpose.

Figure 3.1: sphygmomanometer and Stethoscope for measurement of Blood Pressure

Each participant was seated comfortably in a chair with back support, feet flat on the floor, and their left arm positioned at heart level on a table or armrest. This posture was maintained for at least five minutes before the measurement to stabilize cardiovascular function.

An appropriately sized cuff was placed on the upper arm, positioned 2–3 cm above the elbow crease, ensuring the cuff's artery marker aligned with the brachial artery. The stethoscope diaphragm was positioned over the artery, just below the cuff.

The cuff was inflated until the radial pulse could no longer be felt, then pumped 20–30 mmHg higher to ensure arterial occlusion. The cuff was then slowly deflated at a steady rate of 2–3 mmHg per second, while listening for Korotkoff sounds using the stethoscope.

The first audible sound (Phase I) indicated the systolic pressure, while the point where the sound disappeared (Phase V) marked the diastolic pressure. These values were documented in mmHg, using the conventional systolic/diastolic format (e.g., 118/76 mmHg).

To improve reliability, two readings were obtained with a short rest interval between them, and the average value was recorded as the participant's resting blood pressure.

Pupil Size Measurement: Before caffeine administration, baseline pupil size was assessed under standard room lighting using a pupillary distance (PD) ruler, a simple and reliable tool for measuring pupil diameter.

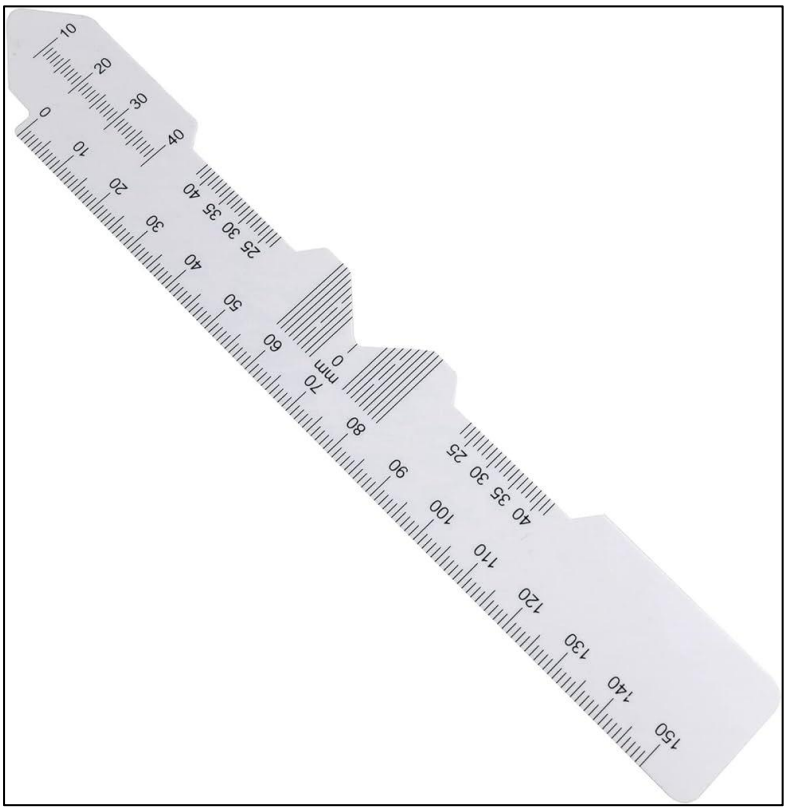

Figure 3.2: Pupillary distance ruler for Measurement of Pupil size

Participants were instructed to maintain a steady gaze at a distant target positioned at eye level to ensure a consistent state of accommodation and fixation. While the PD ruler was held horizontally, just above the upper eyelids, aligning the zero mark with the nasal edge of the pupil of the right eye.

The ruler was then used to read the millimeter marking at the temporal edge of the same pupil, giving the horizontal diameter of the pupil. To ensure measurement accuracy, the examiner's line of sight was carefully aligned with the participant's pupil plane to avoid parallax error.

Pupil size was recorded in millimeters (mm). This procedure was repeated for the left eye, and both values were documented as the participant's baseline pupil measurements.

Amplitude of Accommodation Measurement

Before the ingestion of caffeine, the amplitude of accommodation for each participant was evaluated using the push-up to blur technique, a standard clinical method for assessing accommodative function.

The assessment was performed monocularly, with the non_testing eye occluded to isolate the accommodative response of each eye. A well-calibrated near-point ruler was used, and a near vision target (typically one line above the participant's best near visual acuity) was presented on a near card held at 40 cm from the eye under bright, consistent lighting conditions.

The target was gradually moved closer along the ruler toward the participant's eye. The participant was instructed to report the first moment the text appeared blurred and could no longer be made clear, even with effort. This point marked the near point of accommodation.

The distance at which blur occurred was measured in centimeters and then converted into diopters (D) using the formula:

Amplitude of Accommodation (D)= 100/Near Point Distance (cm)

Results were recorded for each eye to establish a baseline measure of the participant's accommodative capacity.

Near Point of Convergence (NPC) Measurement

Before caffeine ingestion, the near point of convergence (NPC) was measured for each participant to determine baseline binocular function.

A fixation target, a white pin head of 3mm, was used along with a calibrated ruler.

Figure 3.3: A 3mm pinhead target for measurement of NPC

Each participant was instructed to maintain focus on the target as it was slowly moved toward the bridge of their nose along the midline.

The point at which one eye lost alignment (indicating a break in fusion), or when the participant reported double vision was observed. This distance was measured in centimeters and recorded as the NPC.

To ensure accuracy and consistency, the measurement was repeated three times, and the average value was calculated for each participant.

3.8.3 INTERVENTION PHASE

- Firstly, participants were advised not to take any caffeine containing products like tea, cola drinks, energy drinks, chocolates 12hours before the study
- And the drink was administered before meal
- Participants were aware of the drink they consumed

3.8.4 POST TEST PHASE

Measurement (amplitude of accommodation, near point of convergence, pupil size and pressure) was repeated at 30, 60, 90 and 120 minutes after consumption.

3.9 DATA ANALYSIS

The data collected in this study were analyzed to evaluate the effect of caffeine on amplitude of accommodation, near point of convergence, pupil size, and blood pressure across five time intervals: baseline, 30 minutes, 60 minutes, 90 minutes, and 120 minutes following caffeine ingestion. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 16.0 (International Business Machines Corporation, Armonk, NY, USA).

Descriptive statistics, including the mean, minimum, maximum, and standard deviation, were computed for each parameter to summarize the overall distribution and trend of the data across time.

Since the data for Amplitude of Accommodation (AoA) did not meet the assumption of normality, the Friedman Test, a non-parametric alternative to Repeated Measures ANOVA was used to determine whether significant differences existed across the five time points.

For the other parameters (Near Point of Convergence, Pupil Diameter, and Blood Pressure), data were normally distributed; therefore, Repeated Measures ANOVA was applied to assess whether caffeine produced statistically significant changes across time. The Mauchly's Test of Sphericity was used to check for sphericity assumptions, and when these assumptions were violated, Greenhouse–Geisser corrections were applied. Additionally, multivariate tests using Pillai's Trace were performed to confirm the main effects of time on each parameter.

For parameters that demonstrated significant time effects, within-subjects contrasts were examined to determine whether the pattern of change over time was linear, quadratic, or otherwise.

All statistical tests were conducted at a 95% confidence level, with a p-value less than 0.05 ($p < 0.05$) considered statistically significant. Results were presented in both tabular and graphical formats to clearly illustrate trends and variations in each measured parameter.

3.10 ETHICAL CONSIDERATION

Ethical clearance was obtained from the Department Research and Ethics Committee of the Department of Optometry, University of Benin, Benin City, in accordance with the tenets of the Declaration of Helsinki. This ensured that the study was not against public interest.

3.11 LIMITATIONS OF STUDY

The study population was clinic based, hence may not be the true representation of the general population.

Another limitation of study is the narrow age range of participants (mean age 22.56±2.29 years), which may limit the generalizability of the findings to other age groups, particularly older adults.

CHAPTER FOUR

4.0 DATA ANALYSIS AND RESULTS

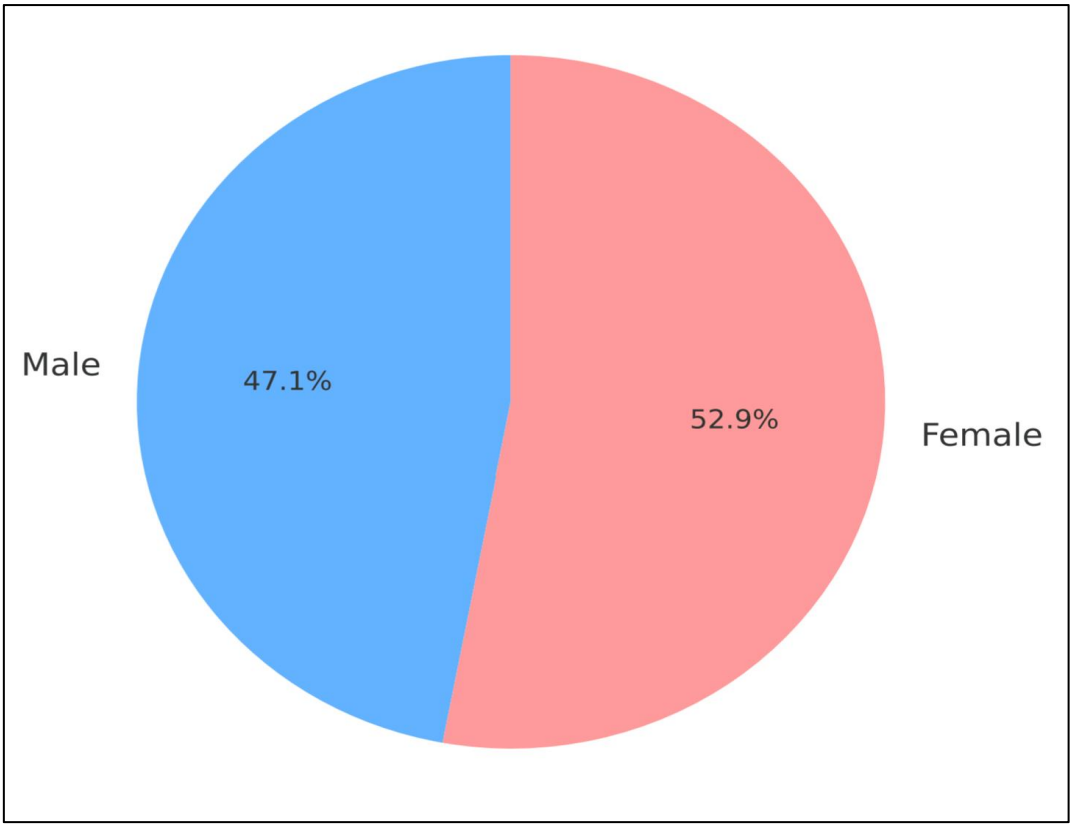

Figure 4.1: Gender Distribution of Participants by Percentage

The figure above shows that both male and female participants were involved in the study. However, a slightly higher percentage of participants were female, while males constituted a smaller proportion of the study population. This indicates a balanced but female-predominant gender distribution among participants.

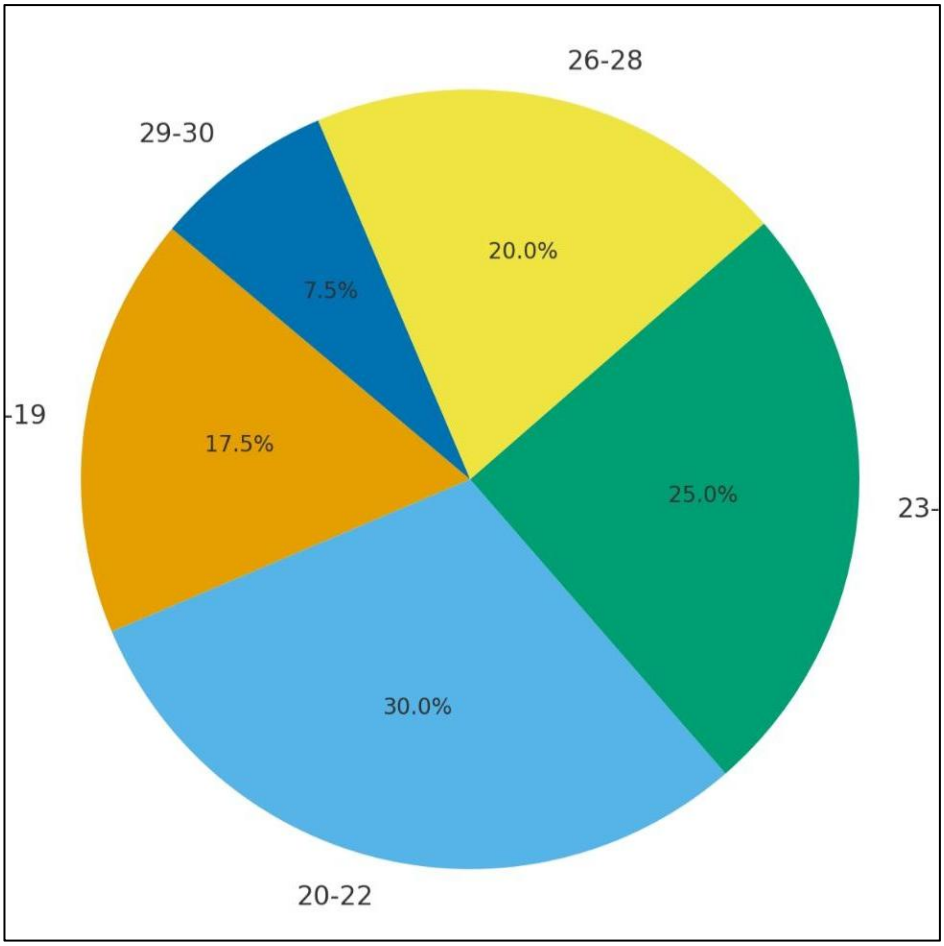

Figure 4.1: Age Range Distribution of Participants by Percentage

The figure above shows the age range distribution of participants involved in the study. The highest proportion of participants (30%) fell within the 20–22 years age range, followed by 23–25 years (25%) and 26–28 years (20%). Participants aged 17–19 years constituted 17.5% of the total population, while the smallest group, 29–30 years, accounted for 7.5%. This indicates that the majority of the participants were young adults predominantly between the ages of 20 and 25 years**.**

4.1 Descriptive analysis on Amplitude of Accommodation

The mean rank for the Amplitude of Accommodation (AoA) demonstrated a clear pattern of change over time. The mean rank increased from 10.18 before caffeine to a peak of 12.18 at 90 minutes post-caffeine, followed by a sharp decline to 10.16 at 120 minutes. This suggests a temporary increase in the accommodative response ability post-ingestion.

Table 4.1: Minimum, maximum and mean accommodative amplitude (dioptres) at different time intervals

Time	Minimum	Maximum	Mean	Std. Deviation
age	17	30	22.90	3.97
Baseline	6.75	16.50	10.18	2.06
30min	6.75	22.25	10.63	2.67
60mins	6.50	19.75	11.23	2.60
90mins	6.00	22.25	12.18	2.69
120mins	6.25	16.50	10.16	2.09

4.2 Inferential analysis (Friedman test)

The effect of time on the Amplitude of Accommodation was assessed using the Friedman Test, a non-parametric test suitable for comparing three or more related samples when distributional assumptions for ANOVA are not met.

The results of the Friedman Test showed a statistically significant difference in the amplitude of accommodation across the five time points ($\chi^2(4) = 112.420$, $p < .001$). This result confirms that caffeine consumption had a significant influence on the Amplitude of Accommodation throughout the measured time intervals.

Table 4.2: Amplitude of accommodation (AOA) summary table

Variables	Values
Test Statistic: Chi-Square (χ^2)	112.420
Degrees of Freedom (df)	4
Asymptotic Significance (p-value)	<.001
Test Used	Friedman Test

4.3 Descriptive analysis on Amplitude of Accommodation

Table 4.3 presents the mean and standard deviation of near point of convergence (NPC) measured before and at different time intervals after caffeine intake. The mean NPC increased progressively after caffeine ingestion, reaching its highest value at 90 minutes (9.02 ± 1.76 cm) before slightly reducing at 120 minutes (7.52 ± 1.48 cm).

Table 4.3: Minimum, maximum and mean Near point of convergence at different time intervals

Time	Minimum break/recovery	Maximum break/recovery	Mean break/recovery	Std. Deviation break/recovery
Baseline	4/7	12/14	7.13/9.68	1.80/1.98
30min	4/7	11/15	7.43/10.41	1.69/1.82
60mins	5/8	12/17	8.25/11.59	1.65/1.92
90mins	6/8	13/17	9.02/12.66	1.76/1.97
120mins	5/7.8	12/15	7.52/10.17	1,48/1.65

4.4 Inferential analysis on Near point of convergence

Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2(9) = 55.61$, $p < .001$. Therefore, degrees of freedom were corrected using the Greenhouse-Geisser estimate ($\varepsilon = 0.566$). The results from the Greenhouse-Geisser–corrected repeated measures ANOVA showed a statistically significant effect of time on near point of convergence, $F(2.27, 88.37) = 37.89$, $p < .001$, partial $\eta^2 = 0.493$.

Similarly, the multivariate test using Pillai's Trace confirmed a significant time effect, Pillai's Trace = 0.669, $F(4, 36) = 18.15$, $p < .001$, partial $\eta^2 = 0.669$. This indicates that caffeine consumption significantly influenced near point of convergence across the measured time intervals, with a large effect size and high observed power (1.00).

Table 4.4: Repeated Measures ANOVA for Near Point of Convergence (NPC) at Different Time Intervals After Caffeine Intake

Variables	Values
Mauchly's Test of Sphericity: χ^2 (9)	555.61
Mauchly's p-value	<.001
Greenhouse-Geisser ε	0.566
Within-subjects effect: F (Greenhouse-Geisser)	F(2.27,88.37) =37.89
Within-subjects p-value	<.001
Partial η^2	0.669

4.5 Descriptive analysis on pupil diameter

The mean pupil diameter increased progressively after caffeine ingestion, reaching its highest value at 90 minutes (4.733±0.4817 mm), before reducing at 120 minutes (4.115±0.5031 mm). Specifically, the mean pupil diameter increased from 3.758 mm before caffeine to 4.217 mm at 30 minutes and 4.560 mm at 60 minutes.

Table 4.5: Minimum, maximum and mean of pupil diameter (mm) at different time intervals

Time	Minimum	Maximum	Mean	Std. Deviation
Baseline	3	4.5	3.758	0.4966
30min	3.3	5.1	4.217	0.5193
60mins	3.8	6	4.56	0.4845
90mins	3.6	6	4.733	0.4817
120mins	3.2	5	4.115	0.5031

4.6 Inferential statistics on pupil diameter

Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2(9) = 35.365$, $p < .001$. Therefore, degrees of freedom were corrected using the Greenhouse-Geisser estimate ($\varepsilon = 0.746$).

The results from the Greenhouse-Geisser–corrected repeated measures ANOVA showed a statistically significant effect of time on pupil diameter, $F(2.982, 116.299) = 126.974$, $p < .001$, partial $\eta^2 = 0.765$.

The multivariate test using Pillai's Trace confirmed a significant time effect, Pillai's Trace=0.931, $F(4,36) = 120.999$, $p < .001$, partial $\eta^2 = 0.931$. This indicates that caffeine

consumption significantly influenced pupil diameter across the measured time intervals, showing a very large effect size and high observed power (1.00).

Within-subjects contrasts revealed a highly significant Quadratic trend ($F(1,39) = 381.315$, $p < .001$, $\eta p^2 = 0.907$), which corresponds to the initial increase, peak, and subsequent decline in pupil diameter observed over the 120 minutes. A significant Linear trend was also noted ($F(1,39) = 81.767$, $p < .001$, $\eta p^2 = 0.677$).

Table 4.6: Pupil diameter Anova summary

Variables	Values
Mauchly's Test of Sphericity: $\chi^2(9)$	35.365
Mauchly's p-value	<.001
Greenhouse-Geisser ε	0.746
Within-subjects effect: F (Greenhouse-Geisser)	F(2.982,116.299) =126.974
Within-subjects p-value	<.001
Partial η^2	0.765

4.7 Descriptive analysis on blood pressure

The mean systolic blood pressure (SBP) increased consistently after caffeine ingestion, reaching its highest value at 120 minutes (139.60±9.103 mmHg). The mean SBP increased from 121.70 mmHg before caffeine to 128.03 mmHg at 30 minutes, 133.35 mmHg at 60 minutes, and 137.38 mmHg at 90 minutes.

Table 4.7: Minimum, maximum and mean of blood pressure (mmHg) at different time intervals

Time	Minimum	Maximum	Mean	Std. Deviation
Baseline	108/64	138/88	121.70/76.75	7.222/5.878
30min	100/68	147/94	128.03/81.18	9.960/6.95
60mins	116/70	152/95	133.35/83.35	9.46/6.514
90mins	120/78	159/100	137.38/87.50	9.262/6.038
120mins	122/68	157/100	139.60/89.45	9.103/7.582

4.8 Inferential analysis of blood pressure

Mauchly's test indicated that the assumption of sphericity was not violated, $\chi^2(9) = 13.549$, $p = .140$. Therefore, the Sphericity Assumed results were reported.

The results from the repeated measures ANOVA showed a statistically significant effect of time on SBP, $F(4,156) = 145.938$, $p < .001$, partial $\eta^2 = 0.789$.

The multivariate test using Pillai's Trace confirmed a significant time effect, Pillai's Trace=0.912, $F(4,36) = 93.628$, $p < .001$, partial $\eta^2 = 0.912$. This indicates that caffeine consumption significantly influenced SBP across the measured time intervals, showing a very large effect size and the highest possible observed power (1.00).

Within-subjects contrasts revealed a highly significant Linear trend ($F(1,39) = 343.530$, $p < .001$, $\eta p^2 = 0.898$), suggesting that the change in SBP over time is predominantly a steady, continuous increase. A significant Quadratic trend was also noted ($F(1,39) = 18.594$, $p < .001$, $\eta p^2 = 0.323$).

Table 4.8: Systolic blood pressure Anova summary

Variables	Values
Mauchly's Test of Sphericity: $\chi^2(9)$	13.549
Mauchly's p-value	.140
Within-subjects effect: F (Sphericity Assumed)	F (4,156) =145.938
Within-subjects p-value	<.001
Partial η^2	0.789

CHAPTER FIVE

5.0 DISCUSSION

Caffeine is one of the most widely consumed stimulants in the world, known for its ability to boost alertness and energy levels. Beyond its effects on mood and attention, caffeine also influences the body's physiological functions, including those of the eyes. This study examined how caffeine affects amplitude of accommodation, near point of convergence, pupil size, and blood pressure, and the results showed that caffeine brings about clear, time-related changes in both visual and systemic responses.

Overall, the study revealed that caffeine causes temporary but significant changes in how the eyes focus, how they work together, and how the body regulates blood flow. Most of these changes became most noticeable around 90 minutes after caffeine intake, before gradually returning to baseline, a pattern that matches caffeine's known short-term action in the body.

5.1 Effect of Caffeine on Amplitude of Accommodation

The amplitude of accommodation, which refers to the eye's ability to shift focus between distant and near objects, showed a noticeable improvement after caffeine consumption. The enhancement peaked around 90 minutes following intake, before gradually returning close to baseline by approximately 120 minutes. This indicates that caffeine provided a temporary boost to the eye's focusing ability, making near vision clearer for a short period.

This short-term improvement is likely linked to caffeine's stimulatory effect on the sympathetic nervous system, which heightens alertness and may enhance the efficiency of the ciliary muscles responsible for lens adjustment. The release of dopamine and norepinephrine

may also play a role, as these neurotransmitters are known to increase neural responsiveness and visual attention.

These findings are consistent with those of Mazzoni et al. (2017), who reported a short-term enhancement in accommodative ability following caffeine intake. In contrast, Saccà et al. (2015) observed no significant change, a difference that could be due to variations in caffeine dosage, participant age, or experimental conditions. Overall, the evidence suggests that caffeine can temporarily sharpen the eye's focusing response, but the effect is short-lived and fades as caffeine levels decline.

5.2 Effect of Caffeine on Near Point of Convergence (NPC)

The near point of convergence (NPC), which reflects how well the eyes work together to focus on a near object, showed slight variation after caffeine consumption. Immediately after intake, a mild improvement was noted, suggesting that caffeine momentarily enhanced binocular coordination and the efficiency of the extraocular muscles. However, as time progressed, a slight decline was observed, indicating that the effect was temporary and not sustained.

This change may be explained by caffeine's stimulation of the central and autonomic nervous systems, which temporarily increases alertness and muscle responsiveness. The initial improvement could be linked to enhanced neuromuscular control of the convergence mechanism, while the later decline might result from fatigue or overstimulation as caffeine levels began to drop.

This finding aligns with the observation made by Patel et al. (2019), who reported that caffeine affects convergence differently among individuals depending on baseline visual stamina and fatigue levels. The slight reduction in convergence observed later in the study

agrees with their report, showing that caffeine can momentarily disrupt the balance between both eyes' coordination, though this effect is short-lived and reversible once caffeine's influence fades.

5.3 Effect of Caffeine on Pupil Diameter

The pupil size, which determines how much light enters the eye, increased slightly after caffeine consumption. The change became noticeable within the first 30 to 60 minutes and coincided with the period of heightened alertness that caffeine is known to produce. This temporary pupil dilation suggests that caffeine stimulates the sympathetic nervous system, which activates the iris dilator muscles and allows more light to enter the eye.

This finding is in agreement with earlier studies by Fredholm et al. (1999) and Loh and Yeo (2015), both of which observed a mild but consistent pupil dilation following caffeine intake. In practical terms, this means that shortly after consuming caffeine, the eyes may become slightly more sensitive to light, and near vision could feel a bit strained because of a reduced depth of field.

However, this effect was found to be temporary and reversible as caffeine levels declined in the body. The brief dilation also appeared to correspond with changes in other visual parameters, such as accommodation, suggesting that caffeine's ocular effects are interconnected and primarily driven by its stimulatory influence on the autonomic nervous system.

5.4 Effect of Caffeine on Blood Pressure

Caffeine caused a clear and steady increase in blood pressure after consumption, with both systolic and diastolic values rising gradually throughout the study period. The elevation was

noticeable within the first 30 minutes, peaked around 90 minutes, and remained slightly above baseline up to 120 minutes. This pattern indicates that caffeine has a temporary but sustained cardiovascular effect, driven by its ability to stimulate the sympathetic nervous system and increase the release of adrenaline and noradrenaline.

This observation supports the findings of Mahmud and Feely (2012), who reported that caffeine significantly increased systolic and diastolic pressures within an hour of intake in healthy young adults, with the effect returning to normal after about two hours. Similarly, Shah et al. (2016) found that energy drinks containing caffeine caused a short-term rise in both blood pressure and heart rate, reflecting caffeine's stimulant action on the cardiovascular system.

Although the increase observed in this study remained within normal limits, it confirms that caffeine's physiological effects extend beyond the brain and eyes, influencing systemic blood flow and cardiac output. Interestingly, the timing of this rise in blood pressure also matched the peak changes in pupil size and accommodation, suggesting that caffeine's systemic and ocular effects are connected through shared autonomic pathways.

5.5 Integration of Findings

Altogether, the findings from this study show that caffeine produces short-lived but clearly noticeable effects on both visual and systemic parameters. It was observed to enhance accommodation and pupil dilation, elevate blood pressure, and slightly reduce convergence ability. These combined effects point to a temporary shift toward sympathetic dominance after caffeine intake, reflecting the body's natural response to stimulation.

The pattern of change across all parameters, with most peaking between 60 and 90 minutes, suggests that this is the period when caffeine's physiological activity is strongest. After this

peak, the gradual return toward baseline shows how quickly the body metabolizes caffeine and re-establishes balance within the autonomic nervous system.

While the overall trends agree with existing research, this study provides a more connected view by showing how these changes occur together rather than separately. Observing accommodation, convergence, pupil size, and blood pressure side by side highlights how caffeine influences the body as a coordinated system, not just as isolated parts. This offers a more complete picture of caffeine's short-term influence on both vision and cardiovascular function, and adds valuable context to understanding how a simple stimulant can momentarily heighten both focus and physiological activity.

CHAPTER SIX

6.0 CONCLUSION

The findings showed that caffeine has a clear and time-related influence on both visual and systemic functions, highlighting just how closely the eyes are linked to the body's autonomic (involuntary) nervous system.

After caffeine was consumed, the results showed a temporary boost in the eye's focusing ability (amplitude of accommodation) and an increase in pupil size, meaning the pupils became slightly more dilated. On the other hand, the near point of convergence which measures how well the two eyes work together at close range became slightly worse for a short period, suggesting that caffeine momentarily reduced binocular coordination. Blood pressure also rose steadily throughout the observation period, confirming caffeine's well-known stimulating effect on the heart and circulation.

Interestingly, most of these changes peaked around 60 and 90 minutes after caffeine intake before gradually returning toward baseline levels. This pattern fits well with caffeine's short-term physiological action and its known half-life of about 2–5 hours. These findings support the idea that caffeine stimulates the sympathetic nervous system (responsible for the "fight or flight" response) while temporarily suppressing parasympathetic activity, which controls rest and relaxation.

From a practical standpoint, this means that caffeine can sharpen visual focus for a short time but may also cause temporary eye strain or imbalance if consumed before prolonged near work, such as reading or studying. For eye care professionals, it highlights the need to consider caffeine intake when performing visual or systemic tests, as recent consumption could affect results for accommodation, convergence, or pupil evaluation.

6.1 RECOMMENDATIONS

Based on the results of this study, the following recommendations are made:

1. Consider Caffeine Intake Before Eye Examinations

Eye care professionals should ask about caffeine use before testing visual functions, since recent intake may temporarily alter accommodation, convergence, or pupil reactions.

2. Promote Public Awareness on Caffeine and Vision

People, especially students and office workers, should be made aware that while caffeine may help improve alertness, it can also cause short-term changes in vision and blood pressure. Moderate and responsible consumption should be encouraged.

3. Encourage the Use of Digital Vision Tools

Future studies and clinical practices should make use of digital or smartphone-based eye testing applications. When properly validated, these tools can help measure vision changes conveniently and in real time.

4. Conduct Broader and Long-Term Studies

Further research should include larger, more diverse groups to determine how gender, age, and habitual caffeine use influence the results. Long-term studies can also help understand whether the body adapts to caffeine's effects over time.

5. Standardize Caffeine Testing Procedures

Researchers should agree on consistent testing conditions including caffeine dosage, time intervals, and lighting to ensure that future studies can be compared and replicated accurately.

6. Apply Findings in Educational and Clinical Settings

These results should guide eye health awareness programs for students, office workers, and the general public. Optometrists can use this information to better advise patients about caffeine use and its short-term impact on visual comfort and efficiency.

REFERENCES

Abokyi, S., Owusu-Mensah, J. & Osei, K. A. (2017). Caffeine intake is associated with pupil dilation and enhanced accommodation. *Eye (London),* 31(4), 615–619.

Anitha, J., Manasa, M., Khanna, N.S., Apoorva, N. & Paul, A. (2023). A comparative study on Peek (smartphone based) visual acuity test and LogMAR visual acuity test. *TNOA Journal of Ophthalmic Science and Research,* 61(1), 94–97.

Ansell, K., Maconachie, G. & Bjerre, A. (2020). Does the EyeChart App for iPhones give comparable measurements to traditional visual acuity charts? *The British and Irish Orthoptic Journal,* 16(1), 19–24.

Aruljyothi, L., Janakiraman, A., Malligarjun, B. & Babu, B.M. (2021). Smartphone applications in ophthalmology: *A quantitative analysis. Indian Journal of Ophthalmology,* 69(3), 548–553.

Cornelis, M.C., El-Sohemy, A. & Kabagambe, E.K. (2018). Genetic variations in caffeine metabolism and their association with blood pressure response to caffeine. *American Journal of Clinical Nutrition,* 107(2), 245–253.

Fredholm, B.B., Bättig, K., Holmén, J., Nehlig, A. & Zvartau, E.E. (1999). Actions of caffeine in the brain with special reference to factors that contribute to its widespread use. *Pharmacological Reviews,* 51(1), 83–133.

Gavrieli, A., Yannakoulia, M., Fragopoulou, E., Kontogianni, M. & Mantzoros, C.S. (2011). Caffeinated and decaffeinated coffee consumption and blood pressure: A randomized crossover trial. *American Journal of Clinical Nutrition*, 94(6), 1497–1502.

Mahmud, A. & Feely, J. (2012). Acute effect of caffeine on arterial stiffness and aortic pressure waveform. *Hypertension,* 45(2), 293–297.

Mesas, A. E., Leon-Muñoz, L. M., Rodriguez-Artalejo, F. & Lopez-Garcia, E. (2011). The effect of coffee on blood pressure: a meta-analysis of randomized controlled trials. *American Journal of Clinical Nutrition*, 93(3), 524–532.

Metsing, M. & Carlson, J. (2023). Lighting conditions and their effect on accommodative accuracy in young adults. *Journal of Vision Science*, 9(3), 145–152.

Millodot, M. (2014). *Dictionary of Optometry and Visual Science*. 8th ed. London: Elsevier.

Myers, M.G. (2004). Caffeine and cardiac arrhythmias: A review of the evidence. *American Journal of Medicine*, 107(2), 186–190.

Naik, S. & Chandra, A. (2023). Caffeine-induced enhancement of amplitude of accommodation in young adults. *Indian Journal of Ophthalmic Research*, 10(4), 202–210.

Nehlig, A. (2016). Effects of coffee/caffeine on brain health and disease: What should I tell my patients? *Practical Neurology,* 16(2), 89–95.

Okuno, T., Sugiyama, T., Kojima, S. & Ikeda, T. (2002). Effects of caffeine on microcirculation of the human ocular fundus. *Investigative Ophthalmology & Visual Science,* 43(3), 3528–3533.

Patel, N.R., John, K. & Walker, L. (2019). The influence of caffeine on binocular vision parameters in university students. *Optometry and Vision Development,* 50(2), 55–62.

Portilla, A., Rivera, J. & Gomez, F. (2022). Systemic health factors affecting accommodation in adults: A cross-sectional analysis. *Clinical and Experimental Optometry*, 105(1), 57–65.

Redondo, B., Vera, J., Carreño-Rodríguez, C., Molina-Romero, R. & Jiménez, R. (2020). Acute effects of caffeine on dynamic accommodative response and pupil size: a placebo-controlled, double-blind, balanced crossover study. *Current Eye Research,* 45(9), 1074–1081.

Redondo, B., Vera, J., Koulieris, G. A., Molina-Romero, R. & Jiménez, R. (2022). Short-term effects of caffeine intake on binocular accommodative facility: a quantitative and qualitative analysis. *Clinical and Experimental Optometry*, 105(5), 534–538.

Rhegan University Study. (2023). Visual fatigue and accommodative stress among digital device users. *Rhegan Journal of Health and Vision*, 15(2), 22–31.

ScienceDirect. (2019). Habitual caffeine intake and its relationship with accommodative stability. [Online]. Available at: https://www.sciencedirect.com [Accessed 22 October 2025].

Shah, S. A., Szeto, A. H., Farewell, R., Shek, A., Fan, D., Quach, K. & Laher, I. (2016). Impact of acute energy-drink consumption on blood pressure and heart rate: a randomized trial. *Clinical Nutrition,* 35(3), 613–619.

Song, X., Li, L. & Zhang, Q. (2024). Caffeine: A multifunctional efficacious molecule—effects on nervous system and circulation. *Comprehensive Reviews in Food Science and Food Safety*, 23(4), 1720–1735.

Terai, N., Desai, S., Spoerl, E. & Pillunat, L. E. (2012). The effect of caffeine on retinal vessel diameter in young adults. *Acta Ophthalmologica*, 90(6), 1–6.

Turnbull, D., Rodricks, J.V., Mariano, G.F. & Chowdhury, F. (2017). Caffeine and cardiovascular health: A review of human evidence. *Food and Chemical Toxicology,* 109, 585–599.

Wikoff, D., Welsh, B. T., Henderson, R., Brorby, G. P., Britt, J., Myers, E., Goldberger, J., Lieberman, H. R., O'Brien, C., Peck, J. & Tenenbein, M. (2017). Systematic review of the potential adverse effects of high caffeine intake in healthy adults. *Food and Chemical Toxicology,* 109, 585–599.

Wilhelm, B., Lüdtke, H. & Wilhelm, H. (2014). The effect of caffeine on spontaneous pupillary oscillations. *Journal of Clinical Neurophysiology*, 31(2), 162–168.

APPENDIX II

EFFECT OF CAFFEINE ON AMPLITUDE OF ACCOMMODATION, NEAR POINT OF CONVERGENCE, PUPIL SIZE AND BLOOD PRESSURE

My name is OKOLI DABERECHI PASCHALIN, a 600l student from the faculty of OPTOMETRY.
THE PURPOSE OF THIS FORM IS TO RECRUIT ELIGIBLE PARTICIPANTS FOR THE STUDY "EFFECT OF CAFFEINE ON AMPLITUDE OF ACCOMMODATION, NEAR POINT OF CONVERGENCE, PUPIL SIZE AND BLOOD PRESSURE IN THE YOUNG NIGERIAN ADULT POPULATION".
NOTE THAT ALL INFORMATION GIVEN WILL REMAIN CONFIDENTIAL, WILL NOT BE DIVULGED TO A THIRD PARTY AND WILL BE USED ONLY AS REGARDS TO THE STUDY.

If eligible, you will be required to come to the OPTOMETRY Clinic for the study which may last between 120_130 minutes as it relates to the study.

* Indicates required question

1. ***Participating in this study is voluntary and you can withdraw at any time.*** *
All response given are confidential and would be used for the sole purpose of the study only.

By ticking 'I Consent ' you confirm that you understand and are willing to participate in this study.

Mark only one oval.

- ◯ I consent
- ◯ I do not consent

BASIC INFORMATION

Note that all information given will remain confidential and will be used for the sole purpose of the study.

2. **NAME** *

_____

3. **AGE (MUST BE BETWEEN 18_30 YRS)** *

_____

4. **GENDER** *

Mark only one oval.

- ◯ Male
- ◯ Female

5. **OCCUPATION** *

_____

6. **WHATSAPP NUMBER** *

_____

7. **WHAT DATE IS CONVENIENCE FOR YOU** *

_____

OCULAR HEALTH

Note that all information given will remain confidential and will be used for the sole purpose of the study.

8. **DO YOU USE PRESCRIPTION GLASSES OR CONTACT LENSES?** *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

9. **HAVE YOU BEING DIGNOSED WITH ANY EYE CONDITION/CONDITIONS?** *

Mark only one oval.

- ◯ Yes
- ◯ No

10. **IF YES, STATE THE EYE CONDITION**

_____

11. **HAVE YOU DONE ANY EYE SURGERY** *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

12. **IF YES, STATE THE EYE SURGERY**

_____

MEDICAL AND LIFESTYLE HISTORY

Note that all information given will remain confidential and will be used for the sole purpose of the study.

13. **DO YOU HAVE ANY OF THE FOLLOWING CONDITIONS?** *

Check all that apply.

- [ ] High blood pressure
- [ ] Heart arrhythmia
- [ ] Diabetes
- [ ] Anxiety or panic disorder
- [ ] Epilepsy or seizures
- [ ] Insomnia
- [ ] None of the above
- [ ] Other: _____

14. **FOR OTHERS, STATE THE CONDITION**

_____

15. **ARE YOU CURRENTLY ON ANY MEDICATIONS, INCLUDING SUPPLEMENTS AND HERBAL REMEDY?** *

Mark only one oval.

- ◯ Yes
- ◯ No

16. **DO YOU SMOKE OR USE ANY NICOTINE PRODUCTS?** *

Mark only one oval.

- ◯ Yes
- ◯ No

17. **ARE YOU PREGNANT OR BREASTFEEDING?** *

Mark only one oval.

- ◯ Yes
- ◯ No

CAFFEINE AND ENERGY DRINK USE AND STUDY COMMITMENT

Note that all information given will remain confidential and will be used for the sole purpose of the study.

18. **DO YOU REGULARLY CONSUMES CAFFEINATED BEVERAGES (COFFEE, TEA, ENERGY DRINKS, ETC)?** *

Mark only one oval.

- ◯ Yes
- ◯ No

19. **HOW OFTEN DO YOU CONSUME ENERGY DRINK?** *

Mark only one oval.

- ◯ Daily
- ◯ Weekly
- ◯ Rarely
- ◯ Never

20. **HAVE YOU EXPERIENCED ANY ADVERSE EFFECTS FROM ENERGY DRINK OR CAFFEINE IN THE PAST?** *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

21. **IF YES, PLEASE DESCRIBE**

_____

_____

_____

_____

_____

22. **ARE YOU WILLING TO CONSUME ONE CAN OF FEARLESS ENERGY DRINK WHICH CONTAIN APPROXIMATELY 160MG OF CAFFEINE DURING THE STUDY SESSION?** *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

23. **ARE YOU WILLING TO ABSTAIN FROM ALL CAFFEINE (COFFEE, ENERGY DRINKS , SODA, ETC) FOR 48HRS BEFORE YOUR SESSION?** *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

APPENDIX III

ID	Age	AOA_Pre_D	AOA_30m_D	AOA_60m_D	AOA_90m_D	AOA_120m_D	NPC_Prec_m	NPC_30m_cm	NPC_60m_cm	NPC_90m_cm	NPC_120m_cm	Pupil_Pre_mm	Pupil_30m_mm	Pupil_60m_mm	Pupil_90m_mm	Pupil_120m_mm	BP_Pre_mmHg	BP_30m_mmHg	BP_60m_mmHg	BP_90m_mmHg	BP_120m_mmHg
P1	19	10.25	10.75	11.75	12.75	11	7/10	8/11	10/13	12/15	8/10	3.8	4.3	4.6	5	4	116/74	120/77	128/82	130/84	134/90
P2	23	9.25	9.75	10.25	11.25	9.25	6/9	7/10	9/12	11/14	7/9	3.2	3.7	4.5	4.5	3.5	127/86	137/91	139/90	138/96	143/94
P3	18	10.50	11	11.75	13	10.50	8/11	9/12	11/14	13/16	9/11	3.3	3.6	3.8	4.5	3.7	115/82	124/85	123/88	129/88	135/90
P4	21	9.75	10.25	11	11.75	9.50	7/10	8/11	10/13	12/15	8/10	4	4.5	4.6	5	4.1	112/68	117/71	125/76	128/80	132/87
P5	20	11	11	11.50	11.25	11	5/7	5/8	6/10	6.5/11	5/8	3.7	4.2	4.5	4.3	3.7	128/83	137/89	139/87	139/88	142/92
P6	30	7.75	8.25	8.50	10	8	5/7	5/8	6/10	7/11	6/8	4.5	5.1	5.3	5.1	4.7	121/84	127/88	132/88	137/91	141/95
P7	24	9	9	10.25	11.75	9.50	8/11	8/10	9/12	9/13	7/10	3.1	3.4	4	4.2	3.2	110/72	115/75	122/79	125/83	132/89
P8	27	8.25	8.25	9.25	10.50	8.75	9/12	9/12	10/13	10/14	9/11	3.8	4.1	4.4	4.3	3.9	120/78	124/81	132/85	135/88	140/94
P9	22	9	9.25	9.5	11.25	9.5	6/8	6/9	7/10	8/13	7/10	3.1	3.6	3.9	3.6	3.2	117/75	121/78	128/82	130/85	136/92
P10	25	8.75	9.25	10.00	11	9	10/13	10/13	10/14	11/14	10/12	3.8	4.3	4.7	4.8	4.2	122/77	134/81	133/81	140/87	144/94
P11	17	9.75	10.25	10.50	11.25	9.5	7/9	7/10	8/11	9/12	7/10	4.3	4.9	4.8	5.2	4.5	108/68	113/70	120/75	124/78	128/82
P12	29	10	10.25	10.75	11.5	9.75	8/11	8/12	9/13	10/14	8/11	4.4	5	5.1	5.4	4.4	124/88	132/94	134/95	138/97	142/100

ID	Age	AOA_Pre_D	AOA_30m_D	AOA_60m_D	AOA_90m_D	AOA_120m_D	NPC_Pre_cm	NPC_30m_cm	NPC_60m_cm	NPC_90m_cm	NPC_120m_cm	Pupil_Pre_mm	Pupil_30m_mm	Pupil_60m_mm	Pupil_90m_mm	Pupil_120m_mm	BP_Pre_mmHg	BP_30m_mmHg	BP_60m_mmHg	BP_90m_mmHg	BP_120m_mmHg
P13	26	8.50	9	9.75	10.50	8.25	6/9	7/10	7/11	8/12	7/9	4.2	4.5	4.6	5.1	4.5	115/71	120/74	128/71	131/82	137/90
P14	20	10	10.50	11	12	10	9/12	10/13	11/14	11/15	9/11	3.6	3.9	4.5	4.5	3.6	122/75	131/79	136/82	140/84	139/84
P15	26	6.75	6.75	6.50	6	6.25	11.5/13.5	11/13	11.5/14	12/15	12/14	4	4.5	4.5	5	5	124/80	124/80	124/80	124/80	124/80
P16	23	11.75	9.25	8	9.50	8	10/11.5	9/13	10/14	10/14	9/10	4	5	6	6	5	116/65	120/70	120/74	140/80	125/68
P17	17	14.25	22.25	16.50	18	14.25	9/11	4/8	6.5/9	5.5/8	7.5/10	3	3.5	4	5	4	126/64	130/68	150/72	148/80	140/68
P18	17	13.25	13.75	13.75	15	13	6.5/8	7/8.5	7/9.0	9/12	7/10	4	4.6	4.6	5	4	137/79	143/84	151/87	148/88	157/83
P19	18	14.25	14.25	15.25	16.75	14.50	8/10	8.5/10	8/10	8/10	8/10	3	3.5	4	4	4	116/70	100/70	116/70	120/89	122/89
P20	20	16.50	14.25	19.75	22.25	16.50	5.5/7.5	8.5/10.5	8.5/11.5	9/13	7/10	4.1	4.5	4.9	5.1	4.4	130/80	138/90	140/90	144/100	150/100
P21	20	11.75	15	18.25	14.50	11.75	9/14	10/15	9.5/16.5	7.5/16.5	7.5/15	4	4.5	5	5	5	128/80	144/90	148/85	150/100	150/100
P22	25	10	10.50	11.75	12.25	11	6/9	6/10	7/11	7.5/12	6/10	3	3.5	4	5	4	118/78	122/82	128/88	128/92	128/88
P23	26	9.50	10.50	11.00	11.25	10.75	7/9	7.5/9.5	9/13	9.5/14	8/13	3	4	4.5	4	4	116/76	120/82	126/86	130/90	130/96
P24	17	12.	13.	13.	15	12.	9/1	9/1	10/	10.	10/1	4	4.5	4.9	5	4.2	117/	126/	129/	127/	128/

ID	Age	AOA_Pre_D	AOA_30m_D	AOA_60m_D	AOA_90m_D	AOA_120m_D	NPC_Pre_cm	NPC_30m_cm	NPC_60m_cm	NPC_90m_cm	NPC_120m_cm	Pupil_Pre_mm	Pupil_30m_mm	Pupil_60m_mm	Pupil_90m_mm	Pupil_120m_mm	BP_Pre_mmHg	BP_30m_mmHg	BP_60m_mmHg	BP_90m_mmHg	BP_120m_mmHg
		75	25	25		75	2	2	13	5/15	3						73	78	79	78	77
P25	25	12	12.25	12.5	14.25	12.25	6/8	7/9.5	7.5/10	9/12	7/10	3.5	4	4	4.7	3.8	132/73	141/76	142/79	147/78	152/83
P26	20	12.75	13	13.5	15	12.75	5.7/8.2	6.3/8.9	6.3/9.2	7.4/9.5	5.9/7.8	4.5	4.9	5	5.1	4.7	132/85	138/89	146/89	149/90	150/91
P27	28	10	10.5	10.75	12.25	9.75	5/7	5/9	7/11	9/13	6/9	4.4	4.8	5.2	5.1	4.5	133/87	145/91	144/95	150/94	146/99
P28	27	10.75	11.25	11.5	12.75	10.75	4/7	5/7	7/10	7.5/10	7.5/9.5	4	4.3	4.9	4.6	4.4	125/75	137/81	133/83	142/90	144/88
P29	21	9.75	10.25	11	12	9.50	7/9	7/10	8/11	8.5/12	8/10	3.1	3.3	3.8	4.2	3.5	138/74	147/77	152/78	159/80	157/82
P30	25	8.75	8.50	9.75	9.75	8.50	9/11	9/12	10/13	10/14	8.5/11	3.9	4.2	4.6	4.7	4.2	122/84	138/93	149/90	157/93	157/94
P31	26	8.50	9	10	11.25	8.25	10/13	10/13	10/14	11/14	10/13	3.8	4.3	4.6	4.3	4	123/79	127/82	135/90	138/90	144/94
P32	18	10.50	10.75	11.75	12.50	11	6/8	6/9	6.5/9	8/11	6/9	3.4	3.7	4.3	4.6	3.8	113/71	117/74	124/79	132/84	142/92
P33	22	9.50	9.25	10.50	11.75	9.75	6/9	7/10	7/11	8/12	6/9	4.4	4.7	5.1	5.4	4.7	116/74	120/77	127/81	139/86	144/92
P34	30	7.50	7.75	8.50	9.25	7.25	6/9	6/10	7/10.5	7.5/12	6.5/9.5	4.4	4.6	5	5.2	4.8	128/83	132/86	140/94	144/94	140/94
P35	27	8.25	8.50	9.25	10	8.25	9/12	9/13	9/13	10/13	9/11	3.3	3.8	4.1	4.2	3.4	119/76	129/81	133/81	130/86	127/82
P36	19	10.25	10.00	10.75	12.25	10.25	5/7	5.5/8	6/9	6/10	6/9	3.1	3.6	3.9	4	3.3	115/73	124/79	126/77	132/83	140/90
P37	28	8	8.5	9.5	10.	8.2	6/8	6/9	7/1	7.5/	6.5/	4	4.5	4.8	4.7	4.2	126/	130/	140/	144/	136/

ID	Age	AOA_Pre_D	AOA_30m_D	AOA_60m_D	AOA_90m_D	AOA_120m_D	NPC_Pre_cm	NPC_30m_cm	NPC_60m_cm	NPC_90m_cm	NPC_120m_cm	Pupil_Pre_mm	Pupil_30m_mm	Pupil_60m_mm	Pupil_90m_mm	Pupil_120m_mm	BP_Pre_mmHg	BP_30m_mmHg	BP_60m_mmHg	BP_90m_mmHg	BP_120m_mmHg
			0	0	75	5			0	9.5	8.5						80	91	92	96	94
P38	20	10	10.25	10.25	11	10	7.0/9.5	7.5/10	7.5/11	8/12	7/9	3.2	3.5	3.9	4.2	3.5	116/73	124/80	124/82	134/90	140/90
P39	27	7.75	8.25	8.75	10	8	4/8	6/9	5/8	7.5/10	5/8	4.4	4.9	4.9	5	4.7	126/81	130/84	138/89	142/92	148/100
P40	23	10.25	10.5	11	12.5	9.75	7/9	7.5/10.5	9/13	10/14	7/8.5	4	4.4	4.6	4.7	4.3	119/76	123/79	130/83	133/86	138/91